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POWER FOR A GRIST MILL

MODERN METHODS IN THE CORN PRODUCTS REFINING CO.'S WORKS

A FEW WEEKS PAST at Argo, a new manufacturing village between Chicago and Joliet, on the line of the Drainage Canal, went into operation one of the most up-to-date power plants, both as to equipment and method of operation, that it has been the good fortune of the writer to inspect. Not only in the power provisions but in all other respects is this plant modern and model. Fireproof at all points, with every convenience for the saving of manual labor, with every safeguard against a possibility of shutting down, with every provision for efficient use of power, it is a delight to the power engineer to make a trip through the factories and power house.

As the name of the company indicates, the work in the plant is that of converting corn into its various products, such as syrup, glucose, meal, and what-not. The plant is, of course, much more than a grist mill, but the grinding is the first process in all cases.

General Plan

AS would be expected, electric motors are used for the drive in all parts of the plant, machinery being driven either by groups or by individual drive, as may best suit the conditions in each room. To avoid any possibility of shut-down and to get quick repairs in emergency, electric cables and all piping for water or steam are carried in tunnels. No piping goes overhead or is buried in the ground, and in these tunnels

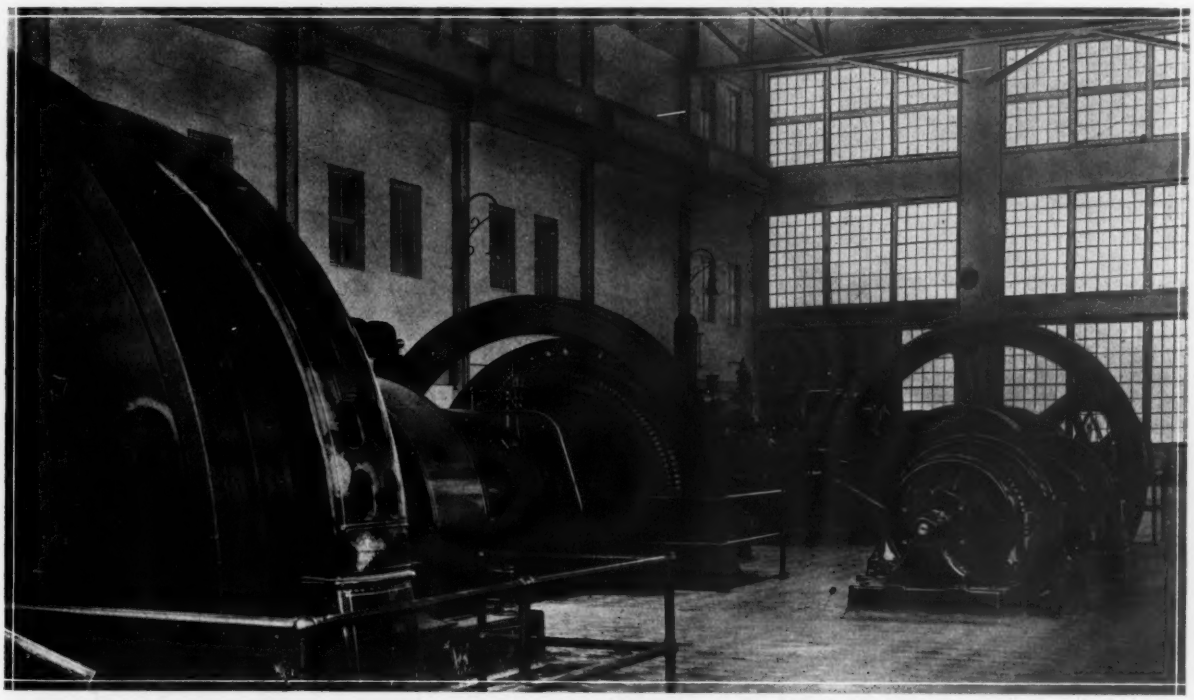


FIG. 5. GENERATOR SETS, SYNCHRONOUS MOTORS AND PUMPING ENGINES AT ARGO

piping may at all times be inspected or worked upon comfortably.

In the reduction of the grain to the various products much steam is needed, so that no occasion arises for condensers or for the provision of cooling water, although such water might easily be had from the Drainage Canal if it were desired. This simplifies the arrangement of the engine units and the piping in the plant, although to one who inspects the power house for the first time and as shown in the plan the pipes are sufficiently numerous so that no further installation of lines seems necessary to give it an air of completeness.

The 2 prime materials in generating power, fuel and water, come from the railroad track which runs alongside the power house and from the Drainage Canal, with a source of water supply in case of

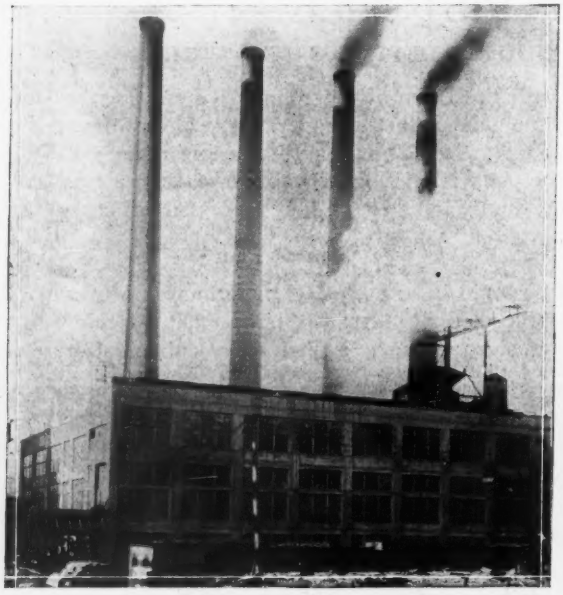


FIG. 1. THE ARGO POWER HOUSE

emergency from an artesian well drilled in one corner of the company's plant. Ordinarily, however, water is pumped by a motor-driven centrifugal pump at the canal bank into a reservoir which is beneath the engine room floor and from there carried to the overhead tank, which supplies the works, or to the boilers, as may be desired.

Coaling Up

NO handling of coal by manual labor is necessary. Two lines of track run beside the power house, and extending over these far above is the arm of a traveling crane located on the roof. From this arm the bucket, like a giant spider, drops his thread downward to the waiting feast below and gorging himself with one snap of his jaws, climbs up the web of wire, to crawl back along the arm of the crane and dumps his load into the storage bins in the power house roof. The traveler is motor-driven back and forth along the length of the roof with the dangling spider scurrying to drop coal at any point until the supply stored is sufficient to last for a case of emergency.

Run-of-mine coal is used and passed through a crusher installed in the frame of the traveling crane. This crane and the hoisting system which goes with it and which it controls, were installed by the C. O. Bartlett & Snow Co., of Cleveland, Ohio, through its Chicago agents, Orton & Steinbrenner.

From the storage hoppers, which are shown in the cross section of the boiler room, the coal drops by gravity to weighing hoppers which were built at the plant by the Corn Products Refining Co. and which rest on Howe scales. Each hopper has a capacity of 25 tons and at morning and at night the weight of coal in each hopper is taken so that the amount of coal used during each 12-hr. period by each one of the boilers is recorded.

Feeding the Furnaces

FROM the scale hoppers through clam shell valves the coal drops to inclined feed pipes which discharge directly into the hoppers of the stokers. By these stokers, which are worthy of comment as to their design and setting, the coal is carried forward under the boilers and the residue of ash and clinker falls over the end of the grate into the ash compartment where it is kept continuously moist to prevent dust flying about the plant, and once in each 24 hr. a helper about the power plant passes an ash car through the tunnel beneath the boilers and dumps into it all the ash of the entire plant, which is then hauled away and used for filling.

Fine coal which may drop through the grates falls into a separate compartment under the front part of the boiler and is again lifted to the hoppers above the stokers. It was found in practice that the coal does not burn well unless moistened, and sprinkling with water did not seem to accomplish the desired result because part of the coal would be excessively wet and part of it would not be moistened at all. A scheme was, therefore, devised by E. R. Skinner, who is at present in charge of the installation, whereby a jet of steam is played upon the coal just as it drops from the spout into the hopper of the stoker. In this way the moisture of the steam can be blown through the coal and it is added at just the right time so that it goes to the fire without the moisture evaporating from the top or settling into the bottom of the mass.

Boiler Features

STOKERS as well as boilers were supplied by the Babcock & Wilcox Co., the stokers being of the chain grate type and the boilers Aultman & Taylor type. The boilers are hung to the steel framing of the building, therefore requiring no special support. They are of the regular Aultman & Taylor construction with brick setting, white enamel fronts for the sake of cleanliness, and with 2 in. of asbestos covering and canvas on top.

Inside the steam drums, at the rear end where steam is taken off, baffle plates have been installed to prevent surging of water into the dry pipe. The feed water is passed into the front end of the drum below the water level and goes the length of the drum before discharging from the feed pipe. This flow is, of course, in the direction of the boiler circulation and before the baffle plates were added some difficulty was found, particularly when forcing the boilers, with the wash of the water as it struck the rear head of the steam drum flying up into the end of the dry pipe nearest. Since the baffle plates have been installed no such difficulty has been experienced.

Stokers are set inclined. There are 2 reasons for doing this: In the first place it brings the rear end of the stoker farther away from the heating surface, which is as it should be. In the second place, if the stoker is set level the arch over the stoker must be built with a roof inclining upward from front to back, and it is much more difficult to build such an arch

than to build an arch which is horizontal from front to back. By tipping the stoker surface it becomes possible to keep the arch horizontal and makes a less expensive arch to build, as well as one which is more durable in use.

To avoid trouble with the stoker gears, cast-iron casings have been made and all gearing is enclosed. The drive for these stokers is from a shaft which runs beneath the boiler room floor the entire length of the plant and is belted at one end to a General Electric motor giving 15 hp. at 750 revolutions. It is of the induction type, taking current at 550 volts. In regular practice 40 to 45 lb. of coal is burned per square foot of grate per hour, the fire being carried about 8 in. thick, and the efficiency for grate and boiler never drops under 70 per cent. Above the grates the arch is 6 ft. in length and is of regular fire-brick construction with cast-iron skewbacks, as these are found much stronger than brick. It was found that the arches wore well and that they might last a good deal longer at the center but are eaten away at the sides

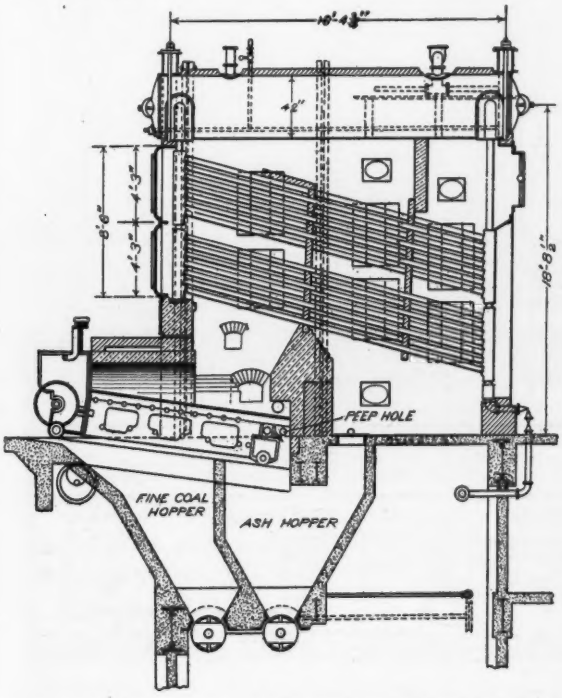


FIG. 2. SECTIONAL VIEW OF BABCOCK AND WILCOX BOILER

where the cold air which creeps along the sides of the furnace strikes them. A steel damper was, therefore, put in at each side, held up against the bottom plate of the arch by a weight and cam, and this quite effectually shuts off the inflow of cold air at this point and has been found to prolong the life of the arches considerably.

In setting the boilers, which are arranged with vertical baffles to direct the course of the gases, the regular iron back plate was used, faced with firebrick. In front of this firebrick facing was put another iron plate and between this iron and the brick was poured a facing of fire clay and cement, the iron plates afterward being removed. This clay surface has been found to help materially in preventing leakage of air through the baffles.

For temporary supply of coal in case of any unusual accident to the coal handling system, a track is run into the boiler room in front of the boilers and this track is carried on a steel structure entirely separate from the building and cushioned with a layer of felt to avoid vibration.

Raising a Draft

BESIDES carrying the boilers, the steel columns behind the boilers are arranged to carry the chimney structures also. These chimneys are started at a height above the boilers and are carried on girders 42 in. deep, which are arranged to carry a reinforced concrete slab and on this slab is built up the chimney proper.

Each chimney extends to 190 ft. from the ground level or 173 ft. from the grate, with the base start-

FIG. 3. IN THE BOILER ROOM; UNITS PART COMPLETED

ing at 47 ft. from the ground. This gives a chance to bring the breeching from 2 boilers into the bottom of a chimney so that the draft is straight up all the way. The chimney construction was by the M. W. Kellogg Co., of New York City, and the drawings and photograph of the plant show the fine character of construction work that was put on the job.

Steam Away

FOR outlet from the boilers 3 methods are provided. The safety valves, which are made by the Ashton Valve Co. and are provided with pipes to

carry the steam through the roof of the boiler house; the blowoff, which is provided for each boiler, with 2 valves, an angle and a straightway, these being the Edward valve and the regular steam nozzle which on each boiler is provided with a Golden-Anderson triple-acting stop and automatic valve, with a Chapman stop valve and bypass in addition.

These Golden-Anderson valves are so arranged that in case the pressure in a boiler falls below that in the steam main the valve will shut and prevent steam from backing up into the boiler. Also in case a steam main or the line from the boiler to the main after it has cooled down. Steam from the boilers comes by a long bend connection to the steam main which is located below the engine room floor.

This main runs the entire length of the power house and all boilers discharge into it, but near the middle are 2 valves which divide the line into 3 sections, and all engine connections, with the exception of that for the largest generator unit, are taken out of this middle section between the 2 valves. Four boilers deliver steam into 1 end section and 4 into the other end section so that, in case of accident to either end section, the remaining 4 boilers could supply

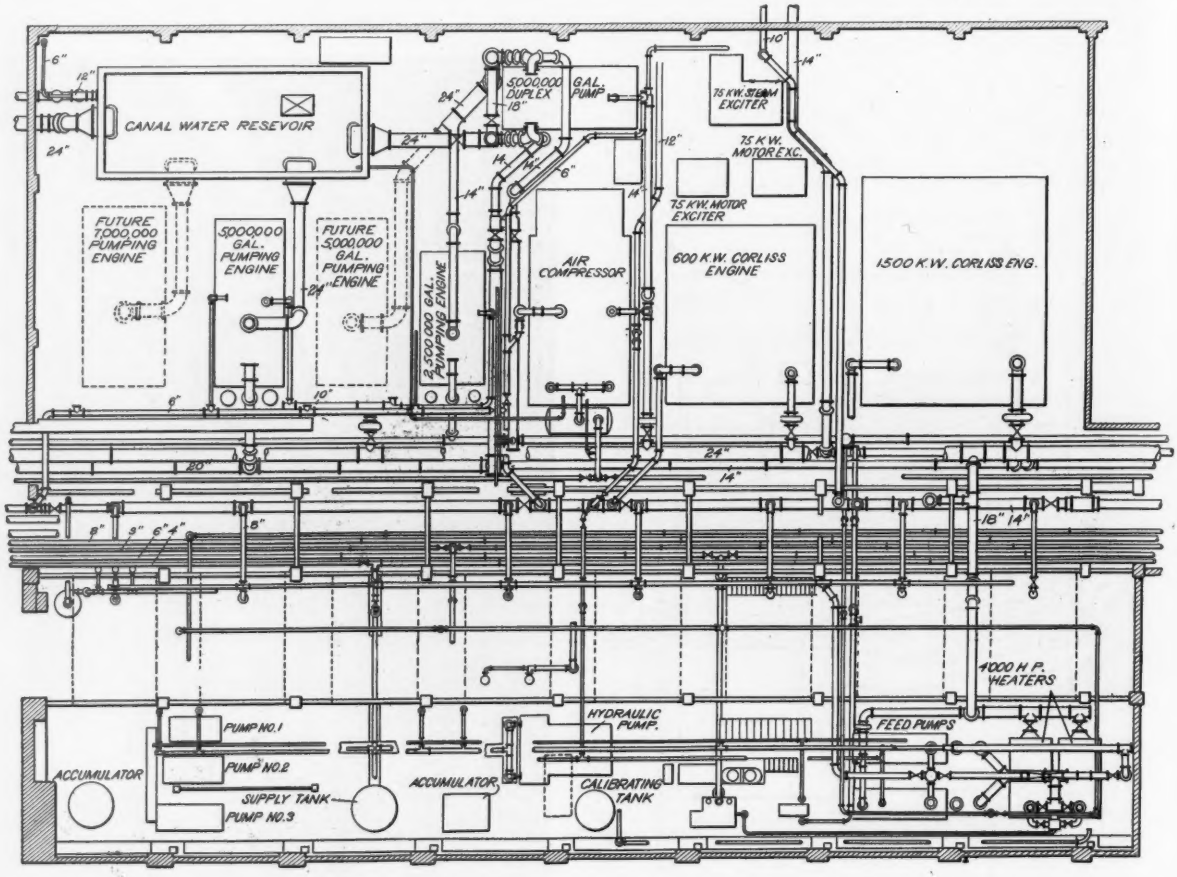


FIG. 4. PLAN OF STEAM AND WATER PIPING IN ARGO POWER PLANT

should burst, the pilot valve will act, thus permitting the steam pressure to close the triple-acting valve and prevent steam from rushing from the boiler into the break in the steam line. These valves have been found to act instantly and so satisfactorily that in ordinary shutting down of a boiler the main stop valve is not closed, the triple-acting valve being depended upon to shut off steam. As a matter of precaution, when the boiler is washed out or a man goes inside to inspect the boiler, the Chapman valve is shut off.

Steam taken from the blowoffs goes to a pipe line laid beneath the boiler room floor and discharges into a sheet steel blowoff tank. The peculiarity of this tank is that the pipe line discharges on a tangent into the tank, thus giving a whirling cyclone effect inside the tank, with the result that the blowoff discharge is absolutely noiseless and there is no vibration in the tank. From this tank the water flows to the sewer steam to the engine room units. A bypass loop is also carried from one end section to the other, with shutoff valves so that, in case of breakdown of the main header, steam could be bypassed from one end section to the other.

Pipes and Pipes

ALL steam piping and hot water piping are covered with Carey 85 per cent magnesia covering, the piping system, as well as all valves and fittings, being furnished by the Crane Co. Exhaust steam from the engines passes to main pipe line which takes steam to the various buildings of the works, where it is used for manufacture. From the auxiliary apparatus in the basement of the boiler house the steam is taken to a pair of Cochrane 4,000-hp. horizontal feed-water heaters from which a relief line runs to the roof and also a cross connection to the main exhaust. Thus the engine exhaust may flow to the factory buildings or to the heaters, or through Klipfel back pressure

valves to vertical exhaust lines, discharging above the power house roof.

To protect the engines and other machinery, Erwood automatic valves are placed on the exhaust from all steam units and on the discharge lines and exhaust from all pumps. Oil is taken out of the exhaust steam by Austin separators before the steam passes to the main exhaust line, and in this exhaust line drop legs are placed which catch any condensation and drain it away through steam traps.

In the discharge from these traps a drop loop has been inserted which gives a water hammer, if steam at any time escapes from the traps. A deep drop loop has also been put in the discharge from the exhaust legs, so that no steam will be carried over from these

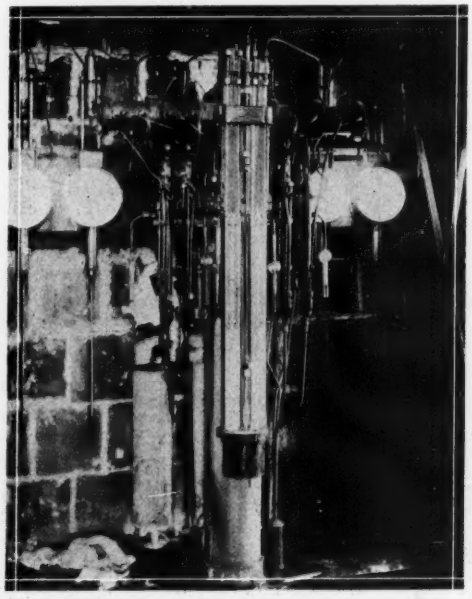


FIG. 5. COMPOSIMETERS FOR 4 BOILERS

drop legs, the loop forming a water seal which will not be blown out by any reasonable amount of pressure in the exhaust pipe.

Austin separators are also used in the steam pipes to collect any condensation in the steam, and to drain these as well as to drain drop legs which are placed in the live steam main V. D. Anderson Co. steam traps are installed.

All drip lines throughout the plant, instead of being carried to the sewer are run with open ends, discharging on the basement floor, thus making it certain that any steam leak will be detected and remedied. Also where traps are used no bypass is provided but a bleed pipe can be opened from the inlet of the trap and this bleed discharges on the floor. In this way, if anything happens to a trap, it can be cut out of service and repaired, but during this process the water which is ordinarily discharged by the trap will be thrown on the basement floor, so that it is needless to say that repairs to the trap will be made as soon as possible.

Discharge from the low-pressure traps goes to the sewer. From the high-pressure traps, as the water will be hot and under some pressure, the discharge is taken to the exhaust line and the heat from this discharge is thus preserved for use in the manufacturing processes.

Checks on Operation

IN operating the boilers, the greatest care is taken to keep the plant in the best condition and to check all operating expense. Not only are weighing hoppers provided whereby all coal used is weighed, but in the feed line a Venturi meter is inserted, with dial to indicate the velocity of flow, recording dial and a recording chart. In this way a continuous record is kept of the evaporation per pound of coal. Also Bristol recording thermometers are provided to give chart records of the flue gas temperature and a continuous record is kept of the percentage of carbon dioxide by sets of composimeters furnished by the Uehling Instrument Co.

Indications of these composimeters are checked each day by the use of an Orsat gas analysis apparatus and for the information of the fireman an indicator near the front of each boiler shows the percentage of carbon dioxide which is present in the uptake from that boiler. A Uehling recording draft gage is also provided for each boiler so that the running conditions can be accurately gaged by the attendant.

As a rule 0.4 in. of water is used as draft pressure and the flue gases are found to have an average temperature of 580 degrees F. and 12 per cent of carbon dioxide. This percentage sometimes runs as high as 14 and if it gets below 10 investigation is started to find out the reason. Charts from recording voltmeters, wattmeters and ammeters give complete daily record of plant performances, so that, as Mr. Skinner says, a complete plant test is conducted every 12 hr. and the exact performance of the installation is worked out by his assistant.

Herewith is reproduced the daily power report which shows with what completeness these daily tests are tabulated and how careful a comparison and analysis can be made between the performances of any 2 days, any 2 months or any 2 plants. To check the Venturi meter readings, a test is made once a week by running the water through the meter and into a large calibrating tank. The indications of the meter are checked against the weight of water in the tank and the accuracy of the meter is thus insured.

Water Works

AS already noted, water for feeding the boilers is taken from the Drainage Canal to a reservoir located beneath the engine room floor. Water may also be taken from the artesian wells by cross connections on the suctions of the twin Burnham pump. The general service water pump is located in the engine room and described in connection with that equipment.

For high-pressure service 2 pairs of Burnham pumps are located in the basement of the boiler house. One of these has 18 and 26 by 20-in. steam cylinders and 7 by 20-in. water cylinders, the steam cylinders being tandem compound and the pumps of the twin type. This pump handles water at 800 lb. per sq. in. for elevator service and lifts in the different buildings. The water is pumped into an Otis accumulator which has a ram 12 in. in diameter and 18 ft. long loaded at the top with cast iron.

The other Burnham pump is 16 and 26 by 5 by 20 in. and operates at 1200 lb. per sq. in., delivering water for hydraulic presses. Both these pumps have outside end-packed plungers and valves of the pot type for high-pressure work. These pumps, as well as the one for general service, are equipped with the twin mechanism and necessary stop valves by means of which either side may be run alone or the 2 sides together as duplex, thus providing duplicate units to insure continuous operation in an emergency. Each

twin set occupies, however, no more space than an ordinary duplex unit and has no more working parts.

The synchronizing valve or mechanism by which the 2 sides of the pumps are kept in step consists of a very simple valve casing in which a plain piston valve is moved by the auxiliary pistons of the pump. This piston valve has no rings. It does not have to be tightly fitted and is so arranged that it keeps the 2 pumps positively in step, and does not in any way interfere with the high efficiency obtainable by the Burnham single pump. Each half of the pump operates its own valve gear so that the pump cannot short stroke. The steam cylinders have the characteristic Burnham exhaust steam cushion arrangement which

tank by a small pump, flows downward and through the water-backs by gravity and then comes up to a discharge at the rear of the boilers where it overflows into funnels and passes off to the sewer. Hot water which may be condensed in the system through the different plants flows by gravity to a tank and is pumped to the Cochrane heaters.

It is, of course, necessary to provide some relay in case of accident to either of the high-pressure pumps which supply water to the elevator service or to the hydraulic presses. For this service 3 small duplex simple pumps are provided, set near one end of the boiler room. These are intended for use only for a brief period and in an emergency.

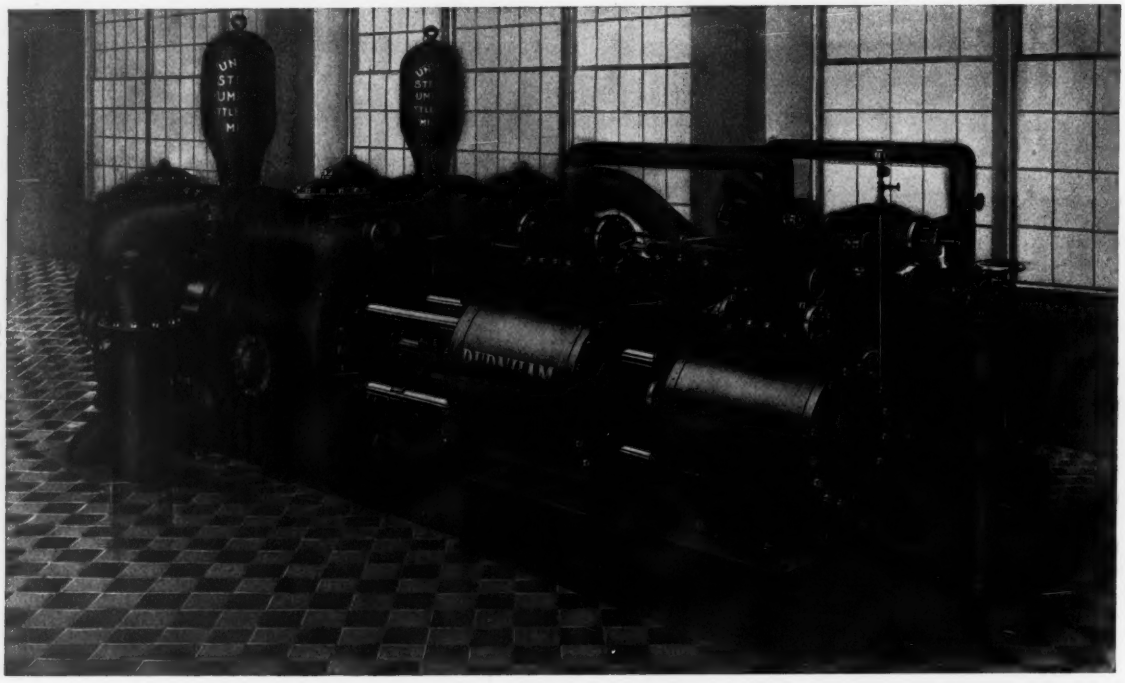


FIG. 6. BURNHAM TWIN PUMPS

effectually prevents the steam piston striking the cylinder head at any speed at which the pump can be operated.

Boiler feeding is accomplished by 2 tandem compound duplex Canton-Hughes steam pumps with outside-packed plungers having cylinders 12 and 20 by 10 by 18 in. These pumps are intended to run in relay, one of them being operated while the other rests. It has been the policy in installing this entire power plant to keep all machinery operating to its limit as much of the time as possible and yet insure continuous operation. Of the 8 boilers which are installed 6 will be used all the time and 7 most of the time, leaving 1 boiler in reserve for washing out and inspection and in like manner the pump equipment has been provided so that there is a margin for possible emergencies, but the entire installation is intended to be kept working at all times.

Feed water is taken to the boilers either by the main feed line which runs up in front of the boilers and delivers water into the front end of the steam drum, or by an auxiliary feed line which discharges into the back end of the boiler. A small pump is provided for pumping water to wash out the boilers and water is delivered through the water-backs of the stokers from a tank on the roof. It is forced to this

Compressed air is used for lifts and for blowing out machinery in the power plant and other buildings of the works, and to provide this an air compressor has been installed, furnished by the Pneumatic Tool Co., of Chicago, and delivering air to a receiver placed alongside.

Oil Saving

ANOTHER interesting feature in the boiler room basement is the V. D. Anderson pressure oil filter. Oil flows from the drips on all machines to a tank and is forced by a small pump up through the filter which consists of cast-iron plates with layers of filtering material attached. The oil is forced by pressure up through a series of these filter plates, having been thoroughly heated, and by this means the foreign matter is entirely removed.

For treating oily waste, a waste-saving machine is provided which separates the oil from the waste and this oil is then forced by water pressure through an auxiliary filter into the receiving tank and is passed through the main filter. This receiving tank is a steel holder having 3 compartments, the oil flowing from the returns into the first one, then passing through the top of a partition to the second compartment, and so on, so that the water is separated out from the oil

in the first 2 compartments, leaving clear oil in the third. After passing through the filter the oil is forced to a tank in the top of the boiler room, from which it is piped to every oil cup on every machine throughout the plant.

In all high-pressure piping extra heavy pipe and fittings have been used and in the main steam header Van Stone joints are provided made by the M. W. Kellogg Co. so that leakage is practically impossible.

Handy Kinks

IN the feed lines solid steel is used for pipe, flanges and fittings. This construction is typical of the care used throughout the plant to have everything of the best quality, both materials and workmanship. Two items in the boiler room indicate the effort to make operating convenient. The spouts from the weighing hoppers to the stoker hoppers are arranged with a trolley at the upper end so that they can be run back out of the way when making any repairs on the stokers or cleaning the boilers. Also on the under flanges of the I beams above the stoker hoppers a chain fall and runner is provided for lifting the hopper gates or any other part which may need to be taken off in the course of repairs or changes. These are small things but they make the difference between easy and rapid operation and bothersome hindrances.

Besides the gravity oiling system from the overhead tank, all machinery is provided with force feed pumps. On the machinery in the engine room Richardson Sight Feed oil pumps are provided and on the pumps in the boiler room McCanna force feed oilers are used.

Engines, Pumping and Lighting

IN the engine room are located all of the pumping engines which supply water for the manufacture of the various products of the company. In this room are also located the generating units which supply power and light for the entire factory, and an air compressor for lifts and cleaning. Ample room has been provided for the present equipment, and when an extension is needed the necessary changes can be made without interfering in any way with the work already done.

Main pumping equipment consists of 2 Laidlaw-Dunn-Gordon pumping engines; one with a capacity of 5,000,000 gal. in 24 hr. is used to pump canal water from the reservoir underneath the engine room to the buildings. This water is used in the boilers and also for condensing purposes in connection with the vacuum pans where glucose is boiled.

The unit consists of a cross-compound noncondensing steam end with double eccentric Corliss valve gear; the steam pressure carried is 160 lb. The water end of the engine has outside packed plunger pistons with an air head on each discharge pipe, and also one at the suction end, carrying discharge pressure of 45 lb. and delivering through an 18-in. pipe. The dimensions of the unit are 12 and 21 by 13¾ by 24 in.

In order that a check upon the amount of water used may be made continuously, a recording revolution counter is provided with each engine, which is run by a chain from the main shaft, and is of the Uehling make.

The other main pumping engine is of the same make and provided with similar equipment, but has a capacity of 2,000,000 gal. in 24 hr., and is used to pump well water from the main reservoir to tanks at the top of the buildings, whence it is drawn for the processes of the factory. The dimensions of this engine are 12½ and 21 by 10½ by 18 in. The discharge pipe is 12 in. in diameter, and the pressure carried in the discharge line is 70 lb.

The auxiliary pump has a capacity of 5,000,000 gal. in 24 hr., and is a Burnham twin pump made by the Union Steam Pump Co. This pump is provided with a synchronizing valve mechanism which enables it to be used as a single duplex or separate pump, and with the piping arrangement provided can be used for handling either the canal or well water, or if desired, both may be pumped at the same time, an arrangement which eliminates all possibility of a complete shut down due to the failure of a single pump to perform its duty.

The steam end of this pump is of tandem compound, noncondensing type with dimensions 22 and 36 by 26 by 24 in.; the discharge pipes are 14 in. and the suction pipe 18 in. The discharge pressure is the same as that from the main pumping engines, 70 lb.

Air Supply

COMPRESSED air which is used for power and cleaning purposes about the engine room and boilers is furnished by an air compressor known as the Corliss Steam Engine type, having cross-compound cylinders

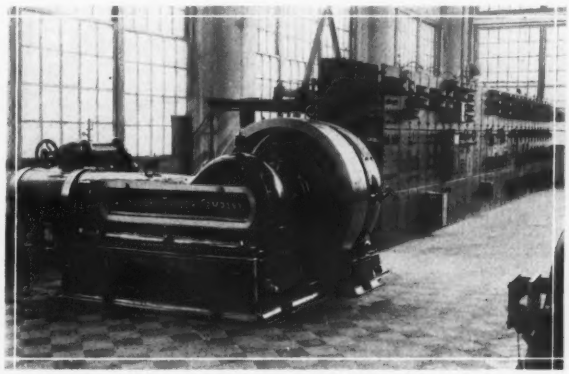


FIG. 7. EXCITER UNIT AND SWITCHBOARD

made by the Allis-Chalmers Co. with duplex single-stage air cylinders, the product of the Ingersoll-Rand Co. The steam cylinders are equipped with the standard form of Corliss valve gear with dash pots, the cutoff being lengthened or shortened by 2 methods, both of which are necessary under certain operating conditions.

Should the plant use a greater amount of air than the compressor can furnish, the engine would tend to run beyond its rated speed; the fly balls would then act in such a manner as to proportion the cutoff so as to keep the machine at a speed no faster than rated speed. This same condition would also exist in case an air pipe line should break.

Then, too, the machine must be governed in accordance with the demand for air, if good steam economy is to be secured, and for this reason an air cylinder with a piston and other necessary connections are attached to the steam governing mechanism, and the air pressure is used to lengthen and shorten the cutoff by acting directly on the cutoff valve rods. This is known as air governing; both the steam and air governor attachments work in connection with each other.

The air is drawn into the cylinders through hollow tail rods of the pistons which are equipped with the Ingersoll-Sergeant piston inlet valves. Each cylinder has 2 valves, one on either side of the piston face, each valve being a continuous ring of high carbon, oil-treated steel, forged without welds. The air ports are annular openings in the piston face. The valves travel with the piston, the one in front closing first by its inertia, and remaining closed under air pressure. The valve behind, as soon as the piston starts, drops back against its stop,

maintaining a full opening until the piston stops, when the valve slides gently to its seat. As the inlet valve cannot open until the clearance air is expanded to atmosphere in the cylinder, there can be no escape of air already compressed.

The discharge valves are of the positive quick closing type, affording the maximum discharge efficiency. The valve itself is machined from selected steel, toughened in oil, annealed, and ground to an accurate seat, the cross section being properly reinforced at points of maximum stress. The valve is free to turn and is, therefore, self-grinding. The large diameter of the valve and its broad contact with the guide assure a uniform wear on the valve and seat.

Pressure carried in the main steam lines is reduced from 160 lb. to 90 lb. by a Leslie reducing valve, and is used at this pressure for operating the compressor, and the air is delivered to the receiver at 90 lb. pressure, the air cylinders being water jacketed with water which is first passed through home-made filters consisting of large flanged pipes with screens across both ends, between which is placed excelsior. The dimensions of this air compressor are 24 and 36 by 24 by 42 in.

piston rods are oiled by Richardson Automatic Oil pumps, while the general lubrication of the engine is done on the gravity system.

The second generator is the same as the one described with the exception that it has a larger capacity of 1500 kw.; it is run in parallel with the first generator. The steam cylinders have the dimensions 30 and 32 by 48 in.

Included in the electrical equipment are 2 Allis-Chalmers motor-generator sets, each of 75 kw. capacity, equipped with synchronous motors, running on 3-phase currents at 600 volts, and delivering direct current at 125 volts from 6-pole generators. These motor generator sets are used for furnishing light and a small amount of power and also for exciting the main generators.

An exciter unit is provided which is used when the generators are started and consists of an Allis-Chalmers direct-current generator, which delivers current at 120 volts, direct connected to a Chandler & Taylor automatic engine, running at 275 r. p. m., having a simple cylinder 14 by 12 in., and controlled by a flywheel governor which regulates the cutoff of the slide valve.

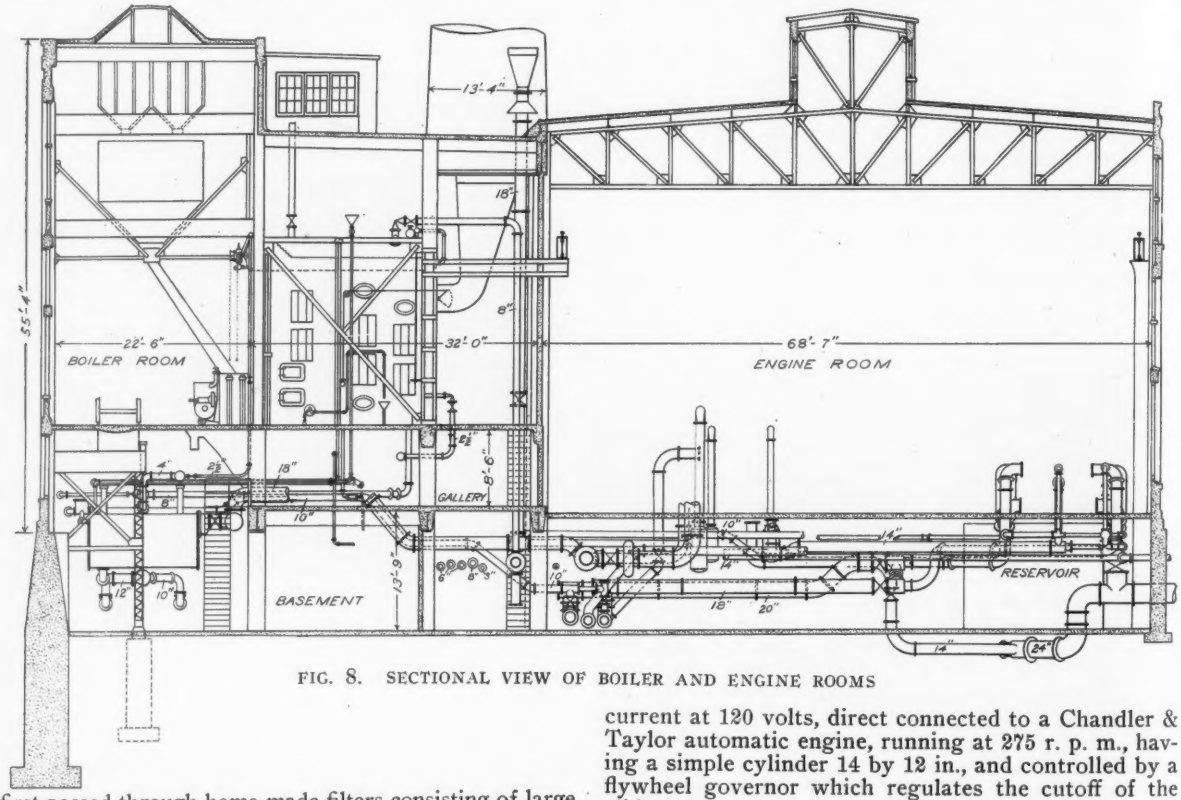


FIG. 8. SECTIONAL VIEW OF BOILER AND ENGINE ROOMS

Current Apparatus

THE main generating units which supply power for the factory are 2 in number. They consist of Allis-Chalmers engines, direct connected to Bullock generators. One generator has a capacity of 600 kw., delivering 3-phase currents at 25 cycles, and 600 volts. It is operated at 125 r. p. m. and has cross-compound steam cylinders running noncondensing, with dimensions 20 and 36 by 36 in. The flywheel is 14 ft. in diameter.

This engine is equipped with an automatic safety stop of the Allis-Chalmers make which is controlled by a separate flyball governor, and insures against racing of the engine. Cylinders, wrist plates and

One of the most attractive features of the engine room is the switchboard and its equipment. The entire board is the product of the General Electric Co., and is made of slate panels upon which the indicating and recording instruments are mounted.

One panel is provided for controlling the excitation of each main generator and one for each motor-generator set, the latter being provided with a double bus bar for direct current, with double throw switches which enable either set to be used for lighting or exciting the generators, or for both purposes, if desired.

A Terrill regulator is used to maintain a constant voltage on the generators. A synchroscope is provided to aid in synchronizing the units and a power-factor meter indicates the power factor of the transmission system.

An exact check on the amount of power used is kept by a curve drawing wattmeter. Fourteen alternating-current feeder panels are each equipped with a recording wattmeter, an ammeter, and an automatic oil switch which acts as a circuit breaker. From these panels 3-wire lead covered cables are led to the transmission lines, where a voltage of 600 is maintained. The service lines have a voltage of 110 which is stepped down from 600 by means of transformers.

For handling the heavy machinery in the engine room during installation or repairing, a 20-ton hand-operated crane is employed, the product of the Whiting Foundry & Equipment Co.

Below Stairs

IN the basement under the engine room is placed all of the auxiliary equipment, steam and water piping used in connection with the engines. One of the most interesting features is the oiling system. This consists of 3 pipes which extend the entire length of the basement, one being used for conveying the cylinder oil, one for the engine oil, and the third for the return to the tank.

Cylinder oil is stored in a 60-gal. iron tank into which it is forced from barrels either by air or water. When air is used the discharge pipe from the barrel is forced through the bung hole to the bottom of the barrel, and air pressure applied at the top. When water is used the reverse of this is employed, that is, the oil is taken from the top and water forced in at the bottom of the barrel. In the line from the barrel to the storage tank is placed a sight glass by means of which the operator can determine when the oil is all out of the barrel. From this tank the cylinder oil is forced by air pressure to the various pumps of the engine room, where it is fed to the cylinders.

Oil used for lubricating the air cylinders of the air compressor is handled in the same way from a storage tank of 50 gal. capacity.

As stated above the engine oil is carried to the engines by gravity. The returns are conducted to a heater where the oil is rendered sufficiently thin to pass readily through a filter, then to a receiving tank from which the oil is forced by a Worthington oil pump through an Anderson No. 3 pressure filter to an 800-gal. tank at the top of the building, whence it is fed back to the engines. The engine bearings are also equipped with oil cups which, in case of accident to the gravity system, will enable the engineer to keep the machinery well lubricated.

Each exhaust steam line is provided with an oil separator of ample capacity, which has a 16-ft. loop at the bottom to insure against loss of steam. An Erwood swinging gate exhaust valve is also placed on the exhaust pipe of each engine for protection against excessive back pressure on the piston in case the operator failed to open the exhaust valve when starting up the engine. Each receiver is equipped with an Anderson low-pressure steam trap, and a high-pressure trap is placed in each steam line to an engine.

In a separate building, attached to the power house, are placed 3 fire pumps, 18 by 10 by 12 in., product of the Canton-Hughes Pump Co., all of the duplex type with outside packed plungers. Suction is taken from the well water reservoir, and discharged at a pressure of 150 lb. which is maintained at all times by means of Fisher governors with which each pump is equipped. While these pumps are in an entirely separate building from the engine room they are under the supervision of the engineer who can watch their operation through a small hole in the wall between the pump house and the engine room.

One of the commendable features of this plant is the completeness of the gage equipment. Each of the main units is provided with a gage board upon which are mounted 3 Ashcroft indicating gages, used for indicating the steam, receiver, and back pressure on the unit, in the case of the air compressor another gage is added to indicate the air pressure.

On a separate gage board are mounted recording instruments, all of which are the product of Schaeffer & Budenberg.

Because of the nature of the processes, service from this power plant must be continuous; the works can never shut down. It is, therefore, necessary to provide against all contingencies and to be ready for all emergencies. That the plant has been able to start without a hitch and in spite of the occasional accidents which will happen in any new plant to give the needed service, proves that the work of Chief Engineer J. J. Merrill in planning the plant and of E. R. Skinner, who has had charge of erection and putting the plant into service, has been well done. And the provisions for keeping close record of operation insure that the future running will be as satisfactory and successful as the past has been.

DAILY POWER REPORT

ARGO PLANT

19

		7 A. M. to 6 P. M.	6 P. M. to 7 A. M.		7 A. M. to 6 P. M.	6 P. M. to 7 A. M.
1	STEAM PRESSURE MAX.			AVERAGE		
	MIN.					
2	TEMP. OF FEED WATER MAX.			AVERAGE		
	MIN.					
3	FACTOR OF EVAPORATION					
		6 P. M.	7 A. M.			
4	READING OF VENTURI METER CU. FT.					
5	DEDUCT FOR BLOW-OFF					
6	LBS. OF WATER EVAPORATED, ACTUAL					
7	LBS. OF WATER EVAPORATED FROM AND AT 212 DEG.					
8	LBS. OF WATER EVAPORATED FROM AND AT 212 DEG., PER LBS. COAL AS FIRED					
9	LBS. OF WATER EVAPORATED FROM AND AT 212 DEG., PER LBS. DRY COAL					
10	AVERAGE BOILER H. P. DEVELOPED PER HOUR					
11	LBS. OF COAL BURNED PER B. H. P. HOUR					
12	LBS. OF DRY ASH REMOVED					
13	PER CENT OF DRY ASHES. WEIGHT LABORATORY					
14	NUMBER OF BOILERS IN USE					
15	PER CENT OVER RATING (RATING BASED ON 10 SQ. FT. OF H. S.)					
16	KIND OF COAL USED					
17	AVERAGE DRAFT IN INCHES MEASURED ABOVE FIRE					
18	AVERAGE THICKNESS OF FIRE					
19	AVERAGE PER CENT OF C. O. 2					
20	BUSHELS OF CORN GROUND					
21	LBS. OF COAL PER 1,000 BUSHELS OF CORN					
22	LBS. OF COAL BURNED PER SQ. FT. OF GRATE PER HOUR					
23	AVERAGE COST OF COAL PER TON					
24	AVERAGE COST OF EVAPORATION OF 1,000 LBS. OF WATER FROM AND AT 212 DEG.					
25	AVERAGE COST OF COAL PER BUSHEL CORN GROUND					
26	AVERAGE REV. OF CANAL WATER PUMPING ENGINES				No. 1 / No. 2	No. 1 / No. 2
27	AVERAGE REV. OF WELL WATER PUMPING ENGINES				No. 1 / No. 2	No. 1 / No. 2
28	KILOWATT HOURS					
29	AVERAGE LOAD IN K. W. PER HOUR					
30	MAXIMUM LOAD IN K. W.					
31	TIME WHEN ABOVE MAXIMUM LOAD WAS OBSERVED					
32	ENGINES IN USE				Nos.	Nos.
33	DATE WHEN VENTURI METER WAS CALIBRATED LAST					
34	DATE WHEN VENTURI METER WAS CLEANED LAST					

Tons Coal Day ____ $ ____

Signed ____ M. M. " " Night ____ $ ____ Signed ____ Supt.

" " Total ____ $ ____

Remarks: ____

FIG. 10. FORM OF DAILY REPORT SHEET USED BY THE CORN PRODUCTS REFINING CO.'S PLANTS

HOME-MADE, SIMPLE PLANIMETER

ITS PRINCIPLE AND METHOD OF USING IT

THIS may be used for either areas which have all irregular outlines or for those having a straight base line. The method for the former is to place a pin in the middle of the area to be measured and set the notch of the base of the instrument on the pin as shown in Fig. 1. A mark is made at each side of the leg of the planimeter and the leg is then swung in one

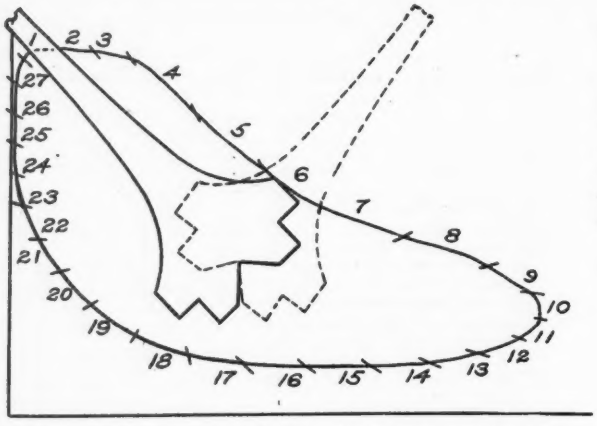


FIG. 1. MEASURING IRREGULAR AREAS FROM A CENTER

direction until the rear edge comes to the mark just made, and a new mark is made at the forward edge of the leg.

The instrument is moved forward again until the back edge comes to the last mark made and a new mark

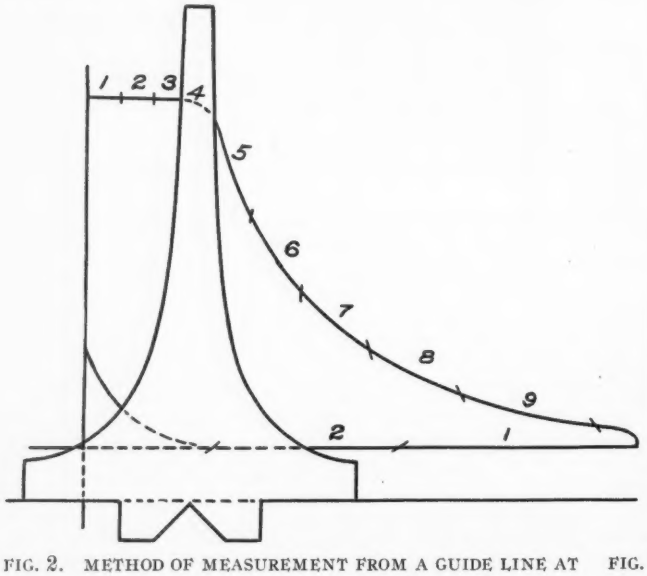


FIG. 2. METHOD OF MEASUREMENT FROM A GUIDE LINE AT ONE EDGE OF THE FIGURE TO BE MEASURED

is made at the forward edge. This process is continued until the whole perimeter of the figure has been covered. The area is thus divided into triangles whose areas are all equal, the area of each depending on the way that the instrument is laid out.

For an area having one straight side, the planimeter is moved along with the base on the straight line, Fig. 2, and marks are made at the edge of the leg on the upper line of the area. In this case the equal areas are four-sided and have an area equal to twice that of each triangle of the first case. Any unequal remainder has to be estimated as a certain part of an equal triangle or quadrilateral. In the case of the card, Fig. 2, the area under the back pressure line is measured and subtracted from the forward pressure line.

Construction of the Instrument

THE working of this simple device depends on the laying out of the curves. The sides are hyperbolas, and are laid out by the method used for the expansion line of the theoretical indicator diagram. First determine the area which shall be used as the unit of measurement. For the indicator diagram, the most convenient area will be 0.1 or 0.2 sq. in., as this will give accuracy and at the same time will give the area in convenient figures for calculation.

Starting with a width of 2 in., Fig. 3, the constant for the curves will be $x\ y = \text{constant}$; as $x = 0.2$ and

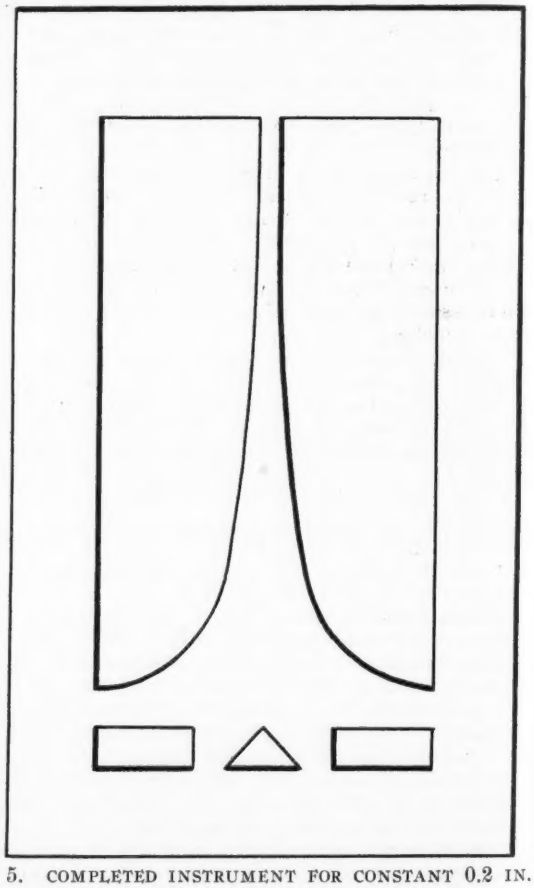


FIG. 5. COMPLETED INSTRUMENT FOR CONSTANT 0.2 IN. CENTERS AND 0.4 IN. WHEN USING GUIDE LINE

$y = 1$. $0.2 \times 1 = 0.2$, the constant. Lay out the center line as shown and the length of 0.2 in. along it from the base line; the distance at right angles to the center line, or parallel to the base line will be 1 in., and this gives the first point on the curve of the planimeter.

If it is desired to carry the curve to the left of this datum line, the distance from the center line to the curve can be found by dividing the constant, 0.2, by the hori-

zontal distance from the base line. In like manner, for any point to the right of the datum line, the distance of the curve from the center line will be the constant divided by the distance from the base line.

To find the curve graphically, drop a line, M N, Fig. 4, from the datum point M of the curve to the center line parallel to the base line, and draw through the datum point a line M P parallel to the center line. From any point as c in this line, draw a line to the intersection o of the base line and the center line and from the point a where the diagonal crosses the datum line and from the point c first chosen drop lines to intersect as shown at ab and cb; the point b will be a point on the curve.

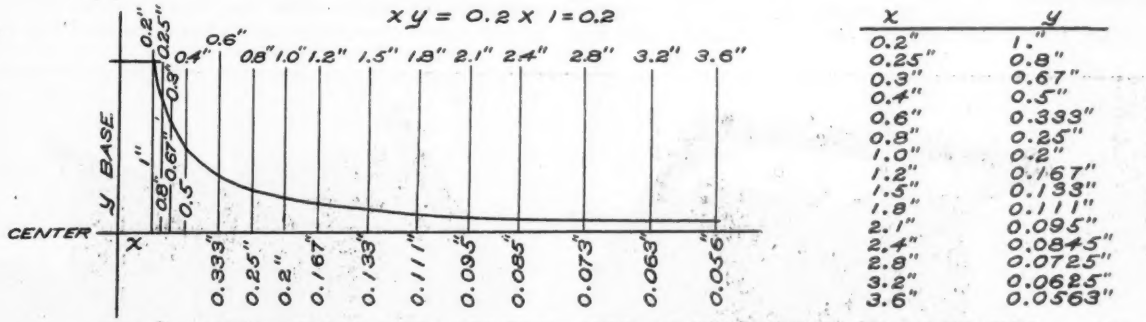


FIG. 3. CONSTRUCTION OF THE BOUNDING CURVE BY MEASUREMENT AND CALCULATION

In this way any number of points can be quickly found, and the entire curve determined as shown in Fig. 4.

From the fact already explained that the distances from the base line and center line multiplied together give a constant, it is evident that the areas of all rectangles formed by these lines as AbCo or DeFo will be the same, Fig. 4. It is evident also that the triangles from the center point o to b and B will be halves of the rectangles, and that the 2 triangles which join to make the triangle boB will equal one of the rectangulars. The

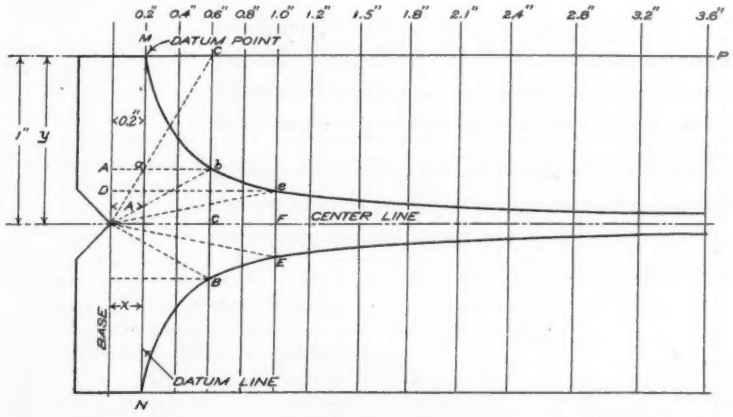


FIG. 4. GRAPHICAL METHOD OF DRAWING THE CURVES

same is true of triangle eoE; hence it is true of all the triangles which might be drawn to the double curve. This proves the statement made at the beginning that all triangles or quadrilaterals marked off in using the instrument are of equal areas.

By taking the constant as 0.1 in., making the length of base line ½ in. each side of the center line and placing the datum line at 0.2 in. from the base line, the curve is made as shown in Fig. 6, which is handier for small cards and for measuring from a center. Fig. 5 shows the completed instrument for a constant = 0.2 in.

Using the Device

FIGURE 1 shows the method for measuring from a center. The pin is placed as near the center of the area as can be estimated and the notch placed against it. Starting at any point, the bounding line is divided into lengths by marking off with the planimeter and the number of triangles is counted. In the case in hand, the instrument with constant = 0.1 for centers was used, and as shown, there were 27 1-3 divisions of the boundary. Multiplying this by 0.1 gives 2.733 sq. in. as the area of the card.

For the card Fig. 2, which has a straight line for a base, it would be possible to measure from the bottom of the card as a guide line with the smaller instrument, but it will not be as accurate as using the line of zero pressure and measuring the area under the forward pressure line, then that under the back pressure line and subtracting.

The larger instrument has been used, and the forward pressure area is 9.25 divisions; the back pressure

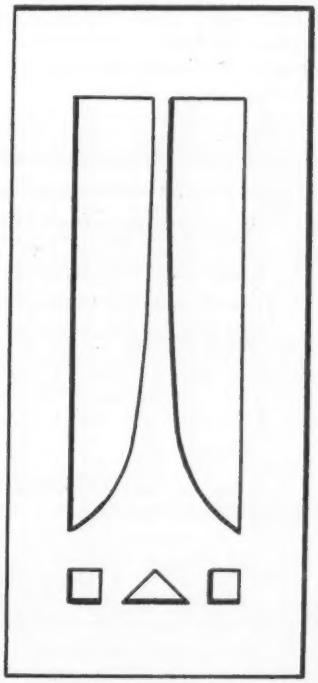


FIG. 6. PLANIMETER WITH CONSTANT 0.1 IN. FOR CENTERS AND 0.2 IN. FOR GUIDE LINE

divisions are 2.95, and the difference is 6.30. Multiplying this by 0.4, as we are measuring quadrilaterals in this instance and the larger constant is to be used, gives 2.520 sq. in. as the area of the figure.

LARGE EVAPORATIVE CONDENSER PLANT

HANDLING 60,000 LB. OF STEAM PER HOUR AT 25 IN. VACUUM

BY C. VAN LANGENDONCK

AT SOUTHEND-ON-SEA (England), the Electricity Corporation Works recently installed at its station, which supplies continuous current at 400 volts for lighting and at 500 volts for traction purposes, a very large evaporative condenser plant. The generating station consists of 6 3-crank triple-expansion compound engines coupled to 150, 250, 350 and 500 kw. dynamos, making a total of 2100 kw. Three Paxman boilers each rated at 6000 lb. steam an hour, 2 Babcock & Wilcox water-tube boilers and 2 Stirling boilers are provided.

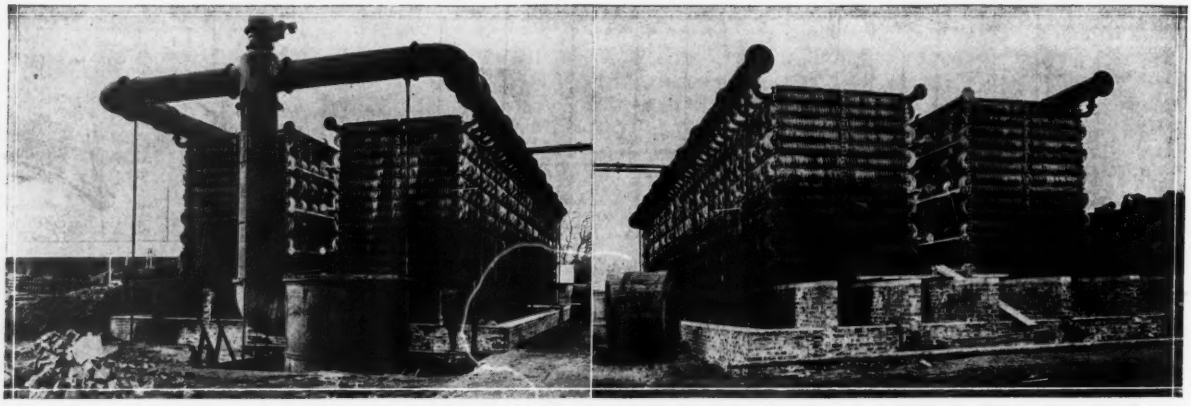


FIG. 1.—TWO VIEWS OF THE CONDENSER

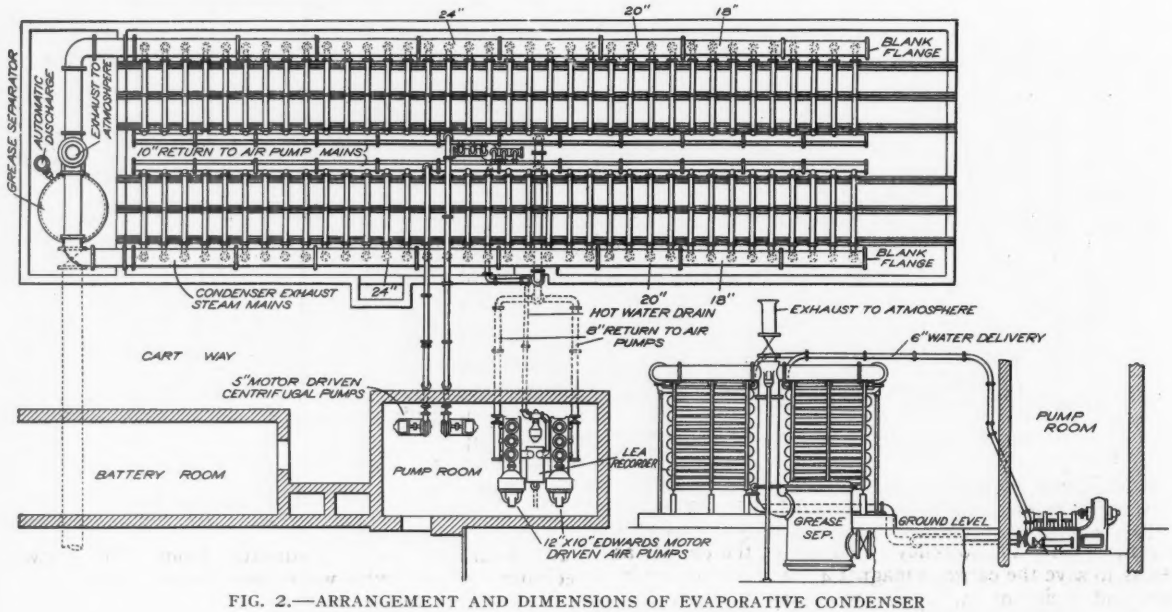


FIG. 2.—ARRANGEMENT AND DIMENSIONS OF EVAPORATIVE CONDENSER

Capacity

THE contract called for a condensing plant to deal with 60,000 lb. of exhaust steam an hour, and to maintain a vacuum of 25 in. under exceptional conditions, there being no water supply other than that from the town mains. The pipes forming the condenser are arranged in 2 sections or groups supported upon a brick and concrete tank which forms the base. Each section is divided into smaller sections, which are separately drained by means of baffles and collectors placed at the ends of the coils in such a way as to separate the water from the vapor. The water of condensation then flows into a common seal box, from which the greater portion of it is taken away hot by a motor-driven pump and delivered straight to the hot-well.

Drainage

PROVISION is made for regulating the sectional drainage to suit the load on the condenser, in order to obtain both a hot feed and a high vacuum at the

same time. Precaution is taken in the design to prevent the whole of the water of condensation being drained from the pipes, as this would prevent the effervescent action that is well known to be necessary for efficient condensation of steam.

The effect of this arrangement is to draw off nearly all the hot water of condensation, practically as soon as it is formed, and to remove it from the condenser without allowing it to go forward and heat up the remaining pipes and air pumps unnecessarily. The low temperature consequently maintained in the air pumps greatly improves the vacuum, and the feed water can be kept at a much higher temperature than would otherwise be the case.

Valves are provided so that the sectional drainage may be easily adjusted to synchronize with the load and thus secure a hot feed on light load as readily as on heavy load. The importance of this is obvious.

Pumps

PUMPS are installed in a separate pump room, and consist of 2 sets of Edwards air pumps, each having 3 barrels, driven direct by a slow speed electric motor. Two centrifugal pumps for circulating the water over the condenser pipes and driven direct by electric motors are also placed in the same pump room.

Cooling water is used only when the atmospheric conditions are very unfavorable, or when the load is heaviest, and it is the practice of the station engineer to regulate the condenser by the temperature of the hot well, which is kept as near as may be at 120 deg. F., this temperature having been found the most economical from all viewpoints.

The condenser is built up of corrugated fluted and grilled pipes, 5 in. smallest internal diameter by 5 ft. long. It is made large enough for the future growth of the station, and the air pumps are in duplicate, but it is found that 1 air pump is sufficient for present requirements, although it is necessary to run this 18 hr. a day.

The Ledward circulating pump is 6 brake horsepower, but owing to the light day load and the large radiating surface it is only necessary to run it 3.5 hr. a day. This works out that the pumps take about 0.25 the energy that would be required to run those of a surface condensing plant. Records of cost show that the water cost per kilowatt hour works out at 0.024 cent, while before putting this condenser into operation this cost was 0.1 cent, a reduction of 76 per cent.

The condenser so far appears to be devoid of any trouble as regards sealing, both externally and internally, and owing to its large capacity the air pump can be shut down for inspection, if necessary, on night load for a short time and on day load for as much as an hour, without experiencing troubles.

DREDGING COAL FROM RIVERS in the coal region of Pennsylvania has been found profitable for some time, the deposits coming from scatterings from barges which settle behind bars in the river bed. Now comes an instance of mining wire nails, barbed wire and hoop iron near New Orleans. A barge loaded with 1,500 tons sank near the wharf, and to relieve the river of the danger as well as to save the cargo, a magnet 43 in. diameter, 10 in. high and weighing 3,200 lb., was manufactured with waterproof insulation. This was successfully operated in 150 ft. of water, lifting kegs of nails, hoops and reels of wire. Rubber garden hose was used to protect the lead wires from the water. The magnet showed itself capable of lifting over 700 lb. at a dip, and in one instance brought up a keg of nails minus the keg but retaining the keg shape.

EASY WAY TO DIVIDE DECIMALS

BY A. L. HODGES

ALMOST every man has trouble in working with decimals, especially in dividing. There is an easy way to do this that is absolutely accurate and automatic in its work, but which not more than one man out of a thousand uses, because he has never seen it. It should be the only one taught in the schools. I may say that I have converted everyone that I have shown it to.

The method is to place the quotient immediately above the dividend, placing the decimal point immediately above the one in the dividend. The first thing to do is to move the decimal point in the divisor to the right until it becomes an integral, now move the decimal point in the dividend the same number of places to the right, adding ciphers if necessary, and then you are ready for work.

Thus dividing .001032 into 65.1302, we have,

```
      00063 110.65
x001032)65x130200.000
        6192
         3210
         3096
          1142
          1032
           1100
           1032
            6800
            6192
             6080
```

First cross out the decimal point in the divisor and move it the 6 places to the right to make the divisor a whole number. Now cross out the one in the dividend and move it the same number of places. Now put a decimal point in the quotient immediately above the new one in the dividend. Now start mentally and say 1032 goes zero times in 6, and put a zero above the 6 either mentally or in fact. Next it goes zero times in 65, so put the zero above the 5. Next it goes zero in 651. Next it goes 6 times in 6513. Now put the 6 above the 3. Notice also that the first significant figure in the quotient always comes just above the last digit of the first subtrahend. Continue on until the operation is carried as far as desired. Now it is at once seen that the decimal point is fixed correctly beyond peradventure of a doubt—and all done automatically.

As regards the right to multiply both divisor and dividend by a decimal number it is at once seen that it is only multiplying both terms of a fraction by the same thing which of course does not alter the value of the fraction—and all division is only the concrete expression of a fraction.

As regards the application of this, it comes in everywhere. It saves time, trouble and errors. I have seen engineers, graduated from well known technical schools who were never sure of their decimal point.

The inventor of this form of division is unknown to me. I was taught it by a progressive teacher when I was a boy, and have used it with joy ever since and have shown as many others as convenient. It is easy to learn and remember—for the mere looking at it once is generally sufficient. Its rapid use is developed in an exceedingly small number of practice examples.

STEAM TURBINES

BULLETIN 176, issued by the B. F. Sturtevant Co., Hyde Park, Mass., describes in detail the improved form of Sturtevant Steam Turbine. This has so many novel features that it is worth examining carefully. Fig. 1 shows the turbine with one side of the casing removed, and the rotating wheel drawn out sufficiently to show the buckets on the edge of the wheel and the nozzle forms and reversing chambers in the casing.

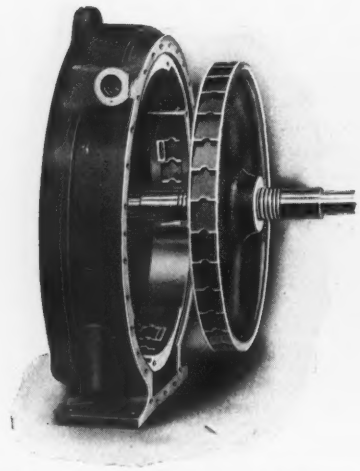


FIG. 1.—STURTEVANT STEAM TURBINE WITH ROTOR PARTLY WITHDRAWN

Steam entering at the inlet shown near the top, passes through and around an annular chamber in the casing, and from this chamber flows through the bronze nozzles shown on the inside of the casing, which deliver the steam at high velocity on the buckets of the rotor. The

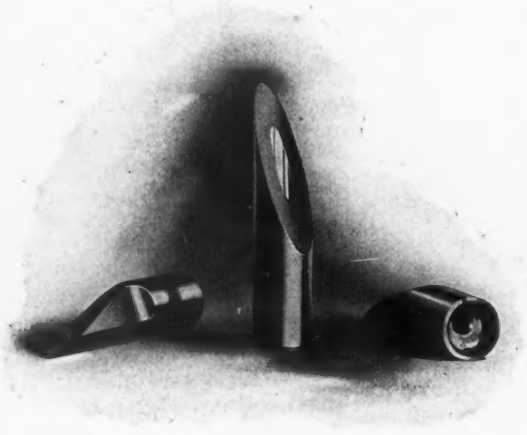


FIG. 2.—TOBIN BRONZE NOZZLES OF THE STURTEVANT TURBINE

bottoms of these buckets are semicircular in form, and the steam strikes on one side. The steam nozzle as shown in the figure is the vertical slot a little to one side of the openings in the casing which resemble the wheel buckets.

Steam flows through one of the buckets on the wheel, and has its direction reversed 180 degrees and is then thrown back into one of the reversing chambers on the casing. In this reversing chamber the direction is again reversed and the steam strikes another bucket. In this way repeated impact of steam on the wheel is created until the velocity of the steam drops nearly to that of the rotor, when the steam is allowed to pass into the exhaust

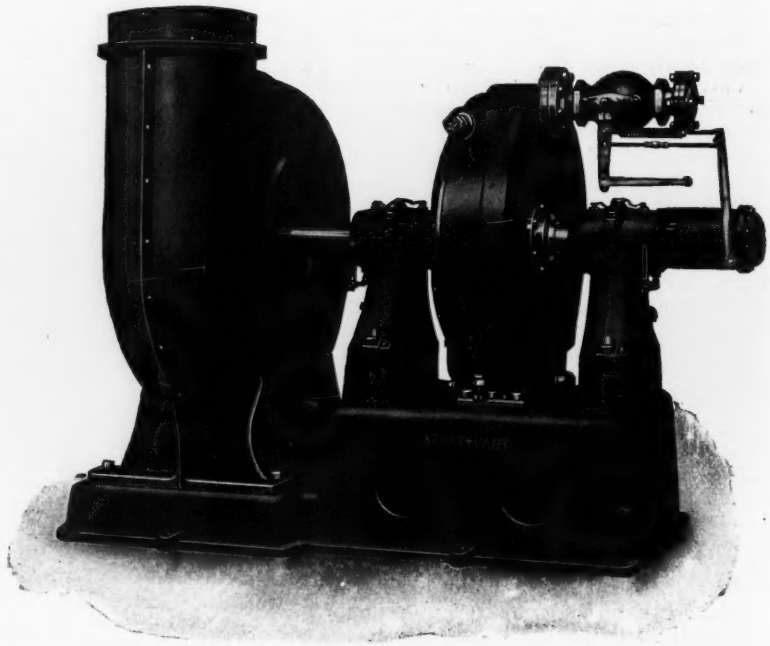


FIG. 6.—STURTEVANT C-3 TURBINE DRIVING A GAS BLOWER

chamber in the casing, and out through the exhaust opening. The Tobin bronze nozzles are shown in Fig. 2. These are designed with opening of such cross section as to expand the steam in the most efficient manner. This Tobin bronze has been used as experience has shown it to resist corrosion, or cutting even after long usage. These nozzles are inserted with a driving pin and held in place by a set screw, and with each nozzle is provided a hand

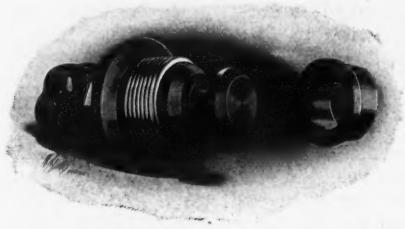


FIG. 3.—VALVE FOR CONTROL OF NOZZLES

operated nozzle valve shown in Fig. 3, so that any nozzle can be closed off in case it is desired to operate the turbine for a long period at light load.

The bucket wheels are made from a single forging of open hearth steel, the buckets being machined into the rim. The wheels are carefully balanced, resulting in quiet running and small wear on the bearings.

Bearings of the Sturtevant turbine are made in halves with ring oiling provision, and oil grooves to distribute the oil over the entire surface. In the smaller sizes, they

are lined with Sturtevant white metal, designed especially for high speed work, and in the larger sizes high grade phosphor bronze bearings are used. To prevent leakage along the shaft, a packing is used of the style shown in Fig. 5, called the Labyrinth packing, and consisting of several series of loose cast-iron split rings running in grooves. There is no absolute point of contact between the rings and the grooves so that the wear is slight and the friction is practically nothing. When in operation, sufficient moisture is obtained from the condensed steam to

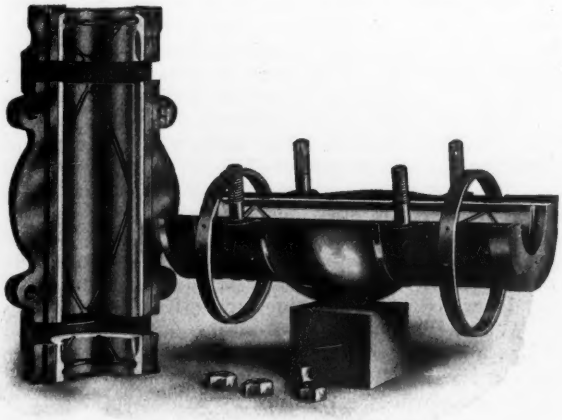


FIG. 4.—BEARING, SHOWING RING OILING, GROOVES AND LINING

keep the rings lubricated, and to prevent leakage of steam past this packing. When operating condensing, it is well to run a pipe from the steam or water supply and allow a little water to run on the rings to insure lubrication and sealing of the air space.

Governing is by the throttling method, the governor being mounted on the end of the shaft and concentric with

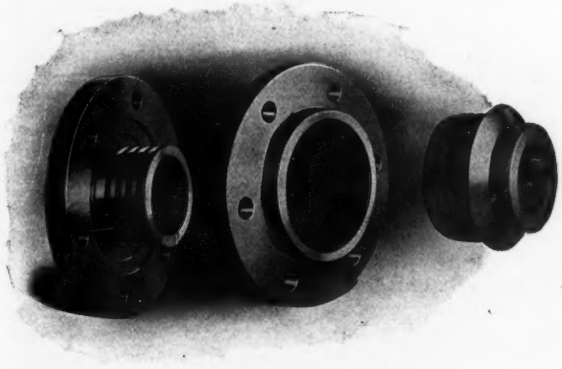


FIG. 5.—LABYRINTH PACKING TO PREVENT STEAM LEAKAGE ALONG THE SHAFT

it. The method of attachment from the governor to the valve is shown in the assembled view of the turbine driving a gas blower, Fig. 6. A regulation of 4 per cent between no load and full load is secured, and with ordinary running conditions the voltage variation will be not over ½ per cent on a generating set. These turbines are made to run economically on loads from 1 to 150 hp. according to the size, and run at speeds of from 1,800 to 3,600 r. p. m.

OUR GRAND BUSINESS is, not to see what lies dimly at a distance, but to do what lies clearly at hand.—Carlyle.

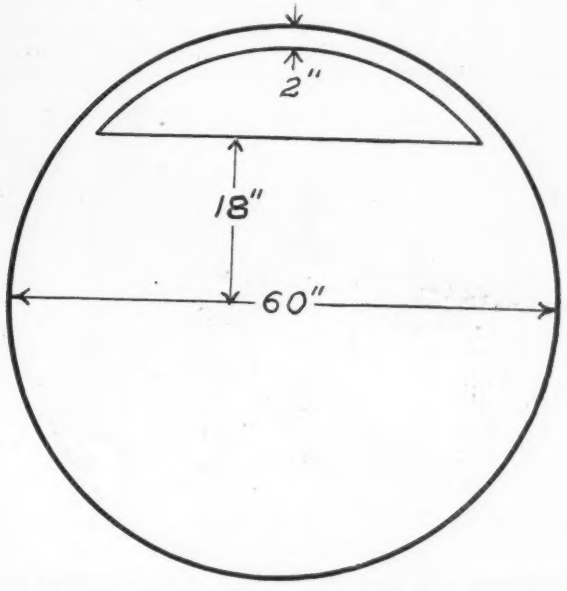
EXAMINATION QUESTIONS

A BOILER 60 in. in diameter, with ten stays, each good for 6000 lb., will carry what steam pressure, the space supported by the stays being as indicated on Fig. 1?

2. The diameter of a high-pressure cylinder is 10 in. and that of the low-pressure cylinder is 20 in., and the cutoff is at ½ the stroke; how many expansions will you get?

3. The diameter of a high-pressure cylinder is 15 in., and the cutoff at ⅝ stroke; what is the diameter of the low-pressure cylinder?

4. What size of a boiler feed pump is needed for a 100-hp. boiler, allowing for 50 per cent overload in emergency cases, and what would be the diameter of both ends of a duplex pump to feed this boiler?



BOILER SHOWING SPACE SUPPORTED BY STAYS

5. Please give a rule for finding the diameter of stays and number of stays for a 74-in. boiler, carrying a steam pressure of 150 lb.

6. The diameter of the high-pressure cylinder is 18 in., and that of the low-pressure cylinder 36 in. Steam pressure is 145 lb. and the cutoff ⅓ the stroke. The stroke is 48 in. What will be the mean effective pressure, and what should be the size of a surface condenser and circulating air pump, and the amount of cooling water needed per hour with the above engine?

7. A cylinder is 24.5 in. in diameter, and the piston speed is 600 ft. a minute; the mean effective pressure is 35 lb. and the horsepower is 300. What should be the diameter of the crank shaft?

8. Give a rule for finding the temperature of steam at a pressure of 175 lb.

This examination was sent us as being given for a New York City License, and we shall be glad to accept and pay for the best set of answers to these questions. Replies should be in our hands not later than the 15th of June.

A MAN DOES NOT know his work when his knowledge stops there; he must know a little all around it.

SLOTH, LIKE RUST, consumes faster than labor wears; while the used key is always bright.—Franklin.

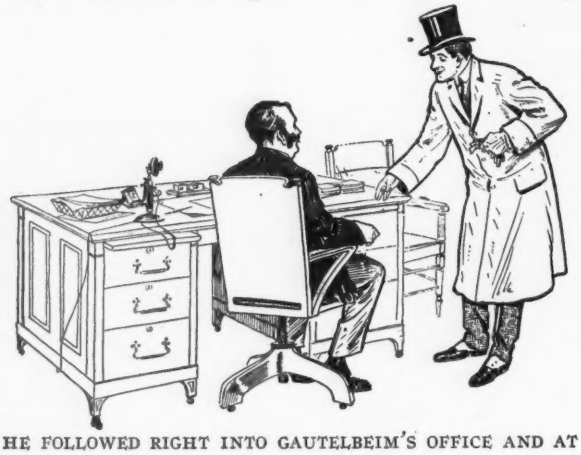
HOW THE NEW CHIEF MADE GOOD

THE DIFFERENT WAYS OF SALESMEN

By George H. Wallace

SOMEHOW or other it "leaked out" that the firm was to make extensive changes and soon there was a large increase in the number of callers, many of whom were from concerns that would make any kind of a price to secure the order and then build the goods to conform to the purchase price regardless of specifications. This class fairly pestered the life out of Willard, like mosquitos on a summer night, "no good to anybody except to keep a man from getting serious."

One day a dashing fashion plate blustered into the office like a young whirlwind. Beginning with a shiny "plug" hat and lavender tie down along a loud large black and white checked suit to his patent leather shoes which covered purple silk socks, he certainly attracted attention. He gave his card to the office boy



HE FOLLOWED RIGHT INTO GAUTELBEIM'S OFFICE AND AT ONCE BEGAN TO TALK

and then followed that important little imp right into Gautelbeim's office, and at once began to talk.

"Young man, I've nothing to do with that; go and see our chief engineer, Mr. Willard; he attends to—"

"But I don't want to see your dirty, greasy engineer. He is not in my class, ye know! I want to see the 'firm,' ye know—"

"You get out of here, you blockhead. You go talking about our greasy engineer and you've put your infernal fool foot in it. Boy, show this—a—er—human checkerboard to the street, his clothes make too much noise," and John went right on with his dictating.

The agent stammered out a "Beg pardon!" and followed the boy into the hall, where he slipped him a dollar.

"Here, kid, where can I find that engineer?" and as Johnnie grinned and pocketed the coin he said, "Come erlong wit me," and together they went over to Willard's office.

"Heyer's a gent t' see yez," and with this unceremonious introduction Johnnie slammed the door and disappeared.

The agent represented Smith, Brown & Jones Co., a firm that made boilers "to sell." Most of them found their way to the fields where a boiler was a boiler as long as it looked like one, and when one read of a boiler explosion in a sawmill or around a drill in the oil fields he could safely say, "I'll bet dollars to dead ducks that was an S., B. & J. boiler."

Willard was quite busy for the moment, but this appeared to be immaterial to his caller. The latter deposited his Boston bag noisily on the floor and threw a genuine Manila filler, cross-compound, long-range, cut-off cigar right down on the page where Willard was writing. While Willard was annoyed beyond measure, he merely brushed this offending article aside and completed his work. This done, he picked up the cigar, broke it in 2, and threw it in the cuspidor.

"Did you wish to—" he began.

"Yes, beg pardon. My name's Chawles Jeames Brumlee Ruskin, ye know—"

"No, I wasn't aware of it," broke in Willard, as he surveyed the rare specimen before him.

"—And I wepresent the S., B. & J. Boiler Works of N'Yawk, and we want to get in on the ground floor heah y' know..? ? ! ! * || = × ¶, etc.," and he threw the lever down in the corner and talked for the record.

Willard stood it for a while and then broke in, "Say, here, you, I don't believe that I have your firm on our list, and I'd like you to know that we buy only from firms whose goods are up to our standard. We don't care to take up any more of your valuable time, Mr.—er—"

"Ruskin."

"Yes."

"Well, but Mr—er—Engineer, we didn't expect you to do all this for nothing. We will make it an object to you to buy our boilers."

"What do you mean, sir?" said Willard, getting his feet under him.

"Well, to come to the point at once, we will give you a rake off of 5 per cent of the contract price and we'll put the price up just that much so that we come out clear. Now, here, I can fix you up with a little of it in advance right now if you but say the word—"

"Yes, I will say the word, and it is this: I work for Baum & Gautelbeim, and they pay me all the salary that I am getting around here. Now, there's the door. Close it from the other side."

And if C. J. B. Ruskin had but known the symptoms he would have done so. But he was too dense.

"Now, heah, me man, don't get so blawsted insolent or I'll have to report you to the firm, ye know—" but that was as far as he got—that is willingly. Willard sprang out of his chair, grasped his visitor by the collar and shot him out of the engine-room door as if he had been a bag of shavings. When C. J. B. R. found that gravity had overcome inertia he was somewhat the worse for wear, as the trip had made a few dents in his apparel. Just then the factory sprinkling wagon came down the yard and Pete, the driver, catching the spirit of the occasion, found, as he drove by, that he could not shut off the water and Alphabetical Ruskin took an involuntary "bawth." Fritz came out just after the shower and yelled:

"Pete! Pete! drive pack vonst more, Ay didn't see dot."

The agent picked up his grip, which Willard had tossed out a little more gently than he had the owner, and made tracks for the office. Gautelbeim came out of his private office just in time to see him enter by the back door.

"Say, that beastly man of yours is rudeness personified. He—" began 'Chawles'.

"Well, how did you come to see him," said Gautelbeim, trying to suppress his mirth.

"Well, that is—he—I—you—he—"

"Shall I tell it for you?" said Willard coming in behind him.

By this time almost the entire office force had gathered around and to cap the climax Mr. Gautelbeim said, turning to the office boy:

"Johnnie, call the ambulance!" But the agent saw fit to "beat it" at once.

A few words explained the entire situation, and while Gautelbeim retired to his office Willard went back to his engine-room.

"Say, Misser Villard, for vy you not vait von little minute?" said Fritz. "I vas bizzy mit der shavings und I only saw der last act. I vos so sorry."

"Well, that's all there was, Fritz, just one act."

"Vell, der heffy villain got it in der neck, all right," and Fritz slapped the leg of his greasy overalls with a pudgy hand, while he chuckled with glee.

This little vaudeville stunt with the crooked boiler agent did not seem to affect the cool, even temper of the chief, for as Fritz returned to his engine Willard tossed his hat on top of the desk, ran his fingers through his hair and sat down to work out additional problems regarding the new power plant.

In about half an hour the door opened and another boiler agent appeared. He had been there once before during the chief's temporary absence from the office looking after his old engines and trying to persuade them to hold together a few weeks longer.

Fritz recognized him, the agent having on his former visit donated a cigar which was exceptionally rank and really make Fritz sick.

"Is Mr. Willard on the job?" said the agent very pleasantly as he offered Fritz another cigar.

"You bets he vos on der chob aber keep dot cigar! Komen hier," said Fritz, as he pointed to a dry spot in the dusty yard just outside the window. "You see dot dry spot? Vell, dot's vere a boiler agent vos a little vile ago ven der sphrinklin' vagon vent by."

"Is that really possible?" exclaimed the agent. And then Fritz told of the little comic opera side show.

"But this chief of yours must be what you might call a bad man," said he.

"Nein, nein. He vos der best man dot you effer saw. Dere vos chust tree men better den der chief."

"Who are the three men?"

"Der Kaiser, Teeadore Rosenfeldet und mine frau Gretchen."

"Well, that is 3 of a kind hard to beat, sure enough. But better have a cigar anyway," said the agent.

"Nein. Dot latst von you gave me schmoked like oakum mixed mit red peppers."

"Ah, yes—I remember now," said the agent. "I guess I got into the wrong pocket for you. That was one that a friend gave me the night before, now that I come to think of it."

"Vell, nopody vould gif a friend a ting like dot und call it a cigar. Und den a man is known py der gompany he keeps—out of," said Fritz, as he went back to fire up.

In the meantime Willard came in and soon the 2 men were in earnest conversation on the subject of boilers. The agent was of the type that ought to be more plentiful than they are; he gave the engineers with whom he came in contact credit for knowing something. All too frequently as soon as some agents for power plant supplies meet the purchaser, they forthwith begin to shoot him full of "hot air" and try to sell him what they want to sell, not what he requires and wants to buy.

"First of all," said Willard, "what are your facilities for turning out the best grade of work? Are you prepared to put 2 boilers complete on the cars in 70 days from signing contract?"

"We can do it in 60 days."

"Well, say 70 days. Are you prepared to cover that proposition financially with bond, cash or check?"

"We certainly are. We carry in stock perhaps the largest assortment of sheets of any concern in this part of the country and we have the machinery and the men to make the goods in the best possible manner with exceptional promptness. If you wish to you may inspect our facilities at our expense and you will not be under any obligations to us by doing so. Here is another thing, Mr. Willard. Our boiler front is made in such a manner that if you desire at any time to install a stoker it is only necessary to remove the lower portion and replace it with whatever your stoker requires. There is no need to put in an entire new front or make any further changes on the boiler in any way."

The agent put forth his best efforts to secure the order on the spot, but Willard would not decide finally

"A MAN IS KNOWN PY DER GOMPANY HE KEEPS—OUT OF," SAID FRITZ

until he had heard from the other boiler concerns with whom he had corresponded, and the agent was diplomatic enough not to try to force the chief to do something against his better judgment.

Within a week, Willard had received prices from all the good concerns whom he had in mind, and also some from the other kind.

Figuring on 175 lb. of steam, the factor of safety ran all the way from 4 to 8. In some, the circulation was free and easy, and in others the water bumped into so many abrupt angles, corners and turns that it would greatly retard the circulation.

One day John Gautelbeim came over upon the chief's invitation and the chief thrust before him a bundle of contracts to look over. They embraced boilers, pumps, excavating, structural work, brick work, concrete work, coal and ash handling apparatus, steam traps, piping, fittings and some other smaller ones, including a little carpentry, pipe covering, plumbing, etc.

"What are these, Willard? What shall I do with them?"

"They are what I think we require here except the engines and electrical equipment, and I'd like to have you

look them over and sign the contracts in behalf of the purchaser."

"Do *you* think they are all right, Willard?"

"Yes."

"Well, then," said Gautelbeim, as he reached for a pen, "if they suit you, they suit me. I don't know as much about engines and boilers as—as—as I *used* to," and laughing over his past mistakes he signed contracts for several hundred thousand dollars' worth of new work as if it were a daily occurrence. Having tossed the last one aside, he said:

"Well, Willard, how are the old ones getting along now?"

"Oh, pretty fair. We used an ounce of prevention on some of the old engines to eliminate a probable ton of cure which otherwise might be found necessary, and I guess they will last 3 months till we get our tunnel in shape and the new boilers in service. Then I'll run steam from the new boilers through the tunnel to the old engines at about 110 lb. pressure, and that will keep us going till the new power house is equipped. In about 2 or 3 weeks when I get all this work under way—get them started on the mason work, and the concrete stack—I'll see about the engines, generators, motors, condensers, etc."

IN SOME THE CIRCULATION WAS FREE AND EASY AND OTHERS WOULD GREATLY RETARD THE CIRCULATION

"There is one thing more I want to tell you about, Willard," said John. "You don't know how good it feels to be relieved of all that burden I've been carrying all these years."

"What burden, may I ask?"

"Well, nobody knew much how to run a plant and I guess I knew less than anybody else. Anyway I wouldn't let anybody dictate to me and everything I did seemed to be the wrong thing and the company lost money on many things that would otherwise be profitable investments. Now that you are looking after the power end and Mr. Mather after the manufacturing end it is so much easier for me to run the business end that I wonder why I never tried all this out long ago. Just think of the money that we wasted. For instance, just listen to the exhaust of that $800,000 gas engine over there that pretty near put me out of business."

Old John stuck a cigar in his mouth and came down on it like a stone crusher. After surveying the exhaust of those old rattletrap engines for a moment he murmured to himself, "Humph," and went back to his office.

EFFECT OF SOOT ON BOILER TUBES

QUANTITY of air admitted to a boiler furnace is a matter having far-reaching effects. With hand firing, frequent opening of doors is absolutely necessary. Advocates of this method say that in this way air is supplied to the top of the coal, and, uniting with the gases rising from the coking fuel causes complete combustion. When the air thus admitted is cold, it reduces the temperature of the gases and of the heating surfaces, and in thus retarding combustion increases the deposit of soot. Every engineer and fireman knows that soot is a poor conductor of heat, but to what extent soot prevents heat transmission is not as definitely known.

Some boiler trials were recently conducted to determine this loss. During the first series of tests soot was allowed to remain on the tubes. The evaporation from and at 212 deg. per pound of dry fuel was 6.2 lb. The dry coal per square foot of grate surface was 13.4 lb., and the temperature of escaping gases 627 deg. F.

Before the second series of tests was made the tubes were carefully cleaned, with the result that the evaporation from and at 212 deg. per pound of dry coal increased to 7.04 lb. of water, a gain of 13.5 per cent. The saving is still further evident from the fact that the amount of dry coal consumed per square foot of grate per hour was reduced from 13.4 to 9.09 lb., and the escaping gases to a temperature of only 546 deg.

Evidently for best economy cold air must not be allowed to cause the deposit of soot. Probably the easiest way to prevent this is the use of a mechanical stoker, which maintains an incandescent fuel bed, with both fan and stoker driven by the same engine so that the air supply is automatically adjusted to the rate of feeding fuel. The advantage of thus controlling the volume of air is that the air is not only of the proper quantity, but when it has passed through the incandescent coal it is of the high temperature necessary to complete the combustion of the gases, and at the same time maintain the high temperature of the heating surfaces.

ENGLAND'S BOY ARMY

IN THE issue of Harper's Weekly for March 26, Sydney Brooks writes of the Boy Scouts of England, the remarkable organization of juvenile soldiers which has enrolled 150,000 members within the last year or two. The Scout Law is comprised in 9 articles, says the author. A scout's honor is to be trusted; a scout is loyal to his king; he is to be useful and to help others; he is a friend to all, and a brother to every other scout; a scout is courteous; he is a friend to animals; he obeys orders; smiles and whistles under all circumstances; and he is thrifty. He must have 12 cents in the bank before he can become a second-class scout, while twice that sum is required before he can become a first-class scout. In addition there are the stalker's badge, the signaller's badge, the cyclist's badge, and many other badges to be obtained by proficiency in certain duties.

DOST THOU LOVE life? Then do not squander time, for that's the stuff life is made of.—Franklin.

"DON'T WORRY about who is going to get credit for your efforts."

VALVE DIAGRAMS

STUDY OF ACTION, AND MEETING CONDITIONS

WITH a given or proposed valve the problem becomes that of finding what the steam distribution will be to the engine; the method can best be illustrated by an actual example.

Problem 1

GIVEN that the eccentric throw is 2 in. the steam lap 1⅛ in. exhaust lap ¼ in., what will be the maximum port opening? Find piston positions for admission, cutoff, release and compression, when the lead is ⅛ in. The crank is 9 in. long and the connection rod 36 in.

From the center O draw the eccentric circle with radius 2 in., and the eccentric center will always be somewhere on this circle. Draw also the horizontal diameter which will lie, of course, on the center line of the engine.

As the maximum port opening is the difference between eccentric throw and steam lap, it will be 2—1⅛= ⅞ in.

On the diagram, the center of the lap circle will be above the center line a distance equal to lap, plus lead, or 1⅛×⅛=1¼ in. Laying this off above the center line and drawing a horizontal, we get the intersection Q, which is the center of the lap circles, and from this center draw the steam lap circle with radius 1⅛ in. and the exhaust lap circle with radius ¼ in.

Crank position for cutoff will then be where the crank center line comes tangent to or just touches the steam lap circle on the upper side, OC; and admission will come where the crank line touches the bottom of the circle, OA. Release is the position OR, where the crank line touches the bottom of the exhaust lap circle, and compression is OM, tangent to the top of that circle.

To get piston positions we need find only crosshead positions, since piston and crosshead are rigidly connected. For this, use a reduced scale ⅛ size, i. e., ⅛ in. represents 1 in. The crank circle will be 18÷8=2¼ in. diameter and will have the same center as the eccentric circle. Crankpin positions for admission, cutoff, release and compression, will be where the crank line positions intersect this circle as at A, C, R and M.

From these points, with radius equal to the connecting rod to scale, i. e., 36÷8=4.5 in., arcs are drawn, cutting the center line and these give crosshead positions A′, C′, R′ and M′ corresponding to the crankpin positions. Dead center positions are located from crankpin dead center and the percentage of stroke for the different events can be measured to scale. In this case they are: Admission, H′A′=0.1 in.=0.555 of 1 per cent; cutoff, H′C′=12.7 in.=70.5 per cent; release, H′R′=17.2 in.= 95.4 per cent; compression, Cr′M′=14.7 in.=81.7 per cent of the return stroke.

Problem 2

FOR an engine with cylinder 10 by 18 in. to run at 150 r. p. m. with lead 1-16 in., cutoff at ¾ stroke, release at 90 per cent of stroke, connecting rod 4 cranks long. Find inside and outside lap, eccentric throw, angle of advance, compression and lay out the resulting indicator diagram.

First, lay out the crank circle, center line, and crosshead travel to ⅛ size; 18÷8=2¼ in. diam. or 1⅛ in. crank, and 4 cranks will be 4½ in. for the connecting rod length. This gives circle with O as center, positions H′ and Cr′ and ¾ stroke is 13½ in. or C′ which gives crank position C, Fig 2.

Flow of steam must be at a rate of, say 6000 ft. a min. through the steam port and the steam used if the engine took steam full stroke, would be the cylinder volume times the strokes per minute. Area for a 10-in. cylinder is 0.545 sq. ft., and this ×1.5=0.818 cu. ft.

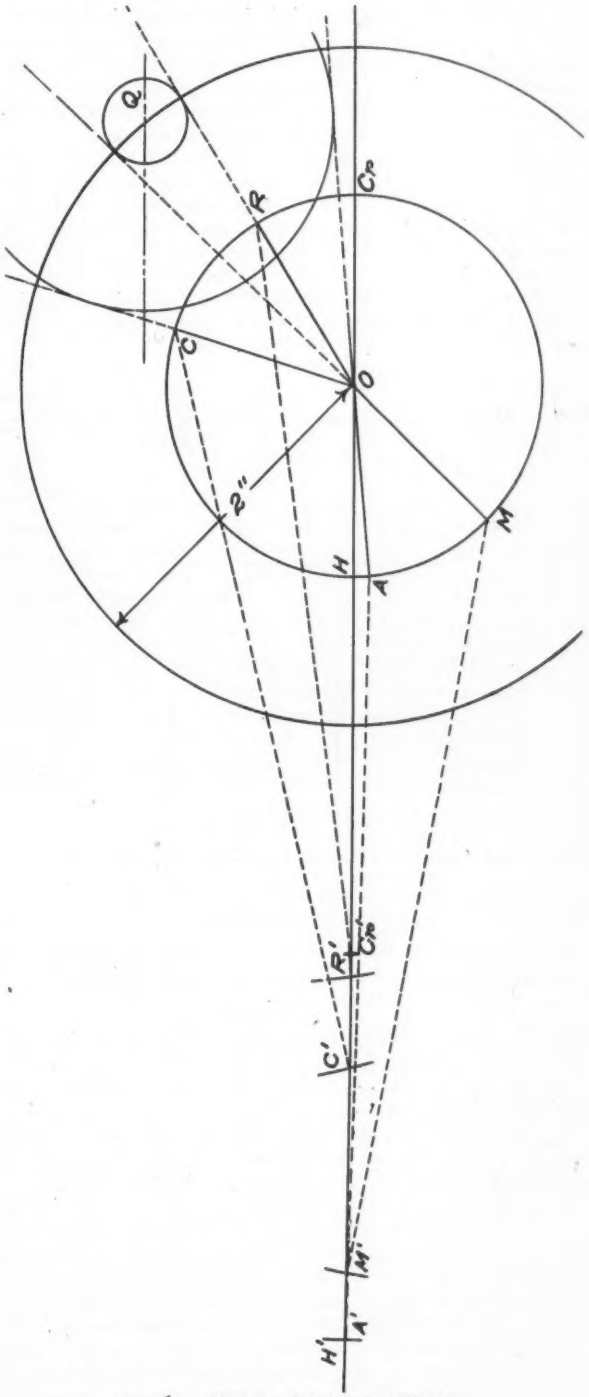


FIG. 1. STUDY OF VALVE ACTION

cylinder volume. The strokes per minute will be 150×2 =300, and steam per minute is 0.818×300=245.4 cu. ft. This divided by 6,000 gives the steam port area and

245.4÷6000=0.0408 sq. ft. or 5.77 sq. in. If the port length be taken as ¾ the cylinder diameter, it will be = 7.5 in. and port opening will be 5.77÷7.5=0.782 in. or a little over 0.75 (=¾) in.

The lap circle must then be tangent to or touch 3 lines; OC, 1 and PP′, the last being an arc 0.78 from O, and 1 being 1-16 in. above the center line to give the required 1-16 in. lead.

By trial with compasses it is found that Q is the center for such a lap circle, and A will then be crank position for admission. The radius of the lap circle is ⅞ in., and QO the eccentric throw measures 1 21-32 in. From OQ to the center line the angle, as measured with a projector, is 35 ¼ deg., which equals the angle of advance.

Ninety-five per cent of 18 in. is 17.1 in., or about 17⅛ in. as at R′. From this point, the connecting rod length swings to R as the crankpin center and crank line at release is OR. A circle from center Q touching OR prolonged is the exhaust lap circle and has a radius ⅛ in., which is the required exhaust lap.

Tangent to this lap on the opposite side is crank line OM, for compression and from M the crosshead position

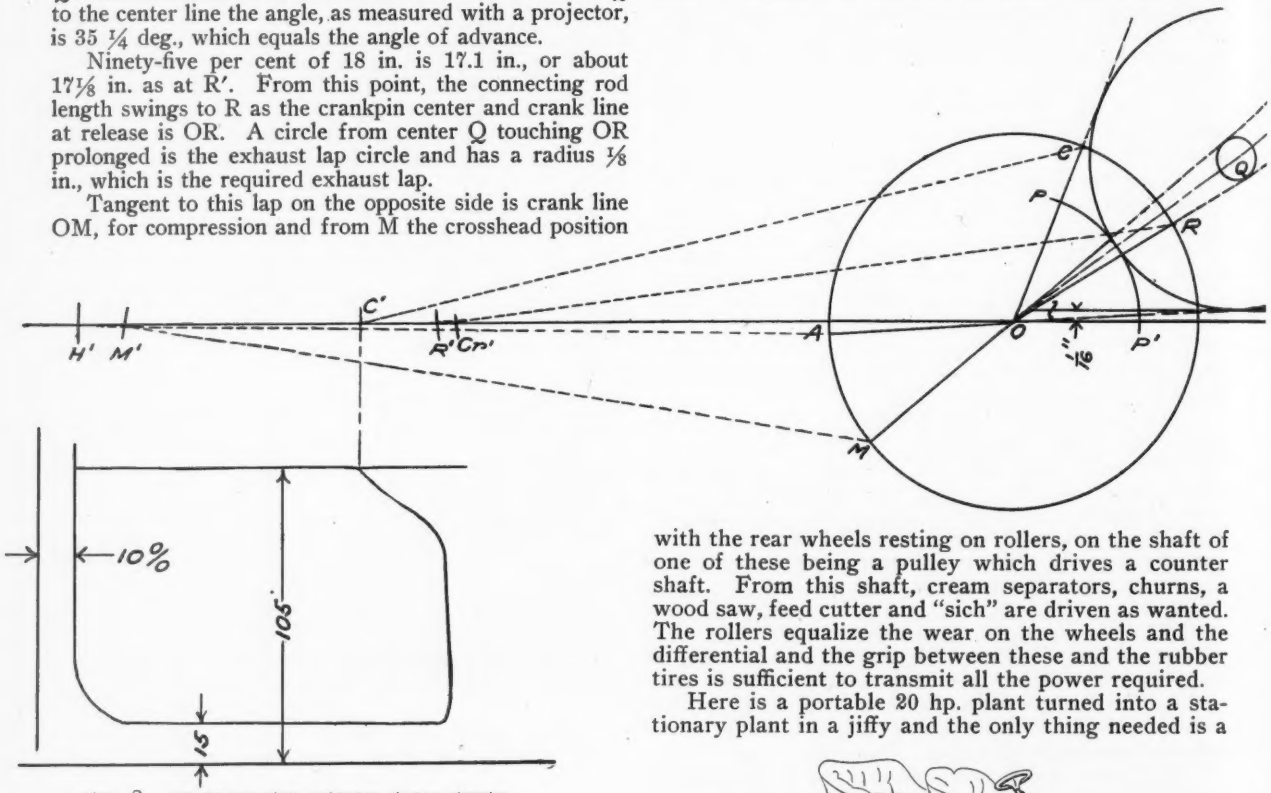


FIG. 2. DIAGRAM FOR DESIGN FROM GIVEN CONDITIONS, PROBLEM 2

M′ is found for compression or exhaust closure at 15¾ in. from Cr′ or 87.5 per cent of the return stroke.

The Diagram

BELOW the crosshead positions is the theoretical diagram. Pressure is at 90 lb. and back pressure atmospheric, and the scale is 60 lb. to the inch. Expansion and compression curves are hyperbolas drawn by the graphical method using a clearance of 10 per cent. It is a snub-nosed card and the conditions certainly ought to be changed to get a good running and economical engine.

LEATHER BELT CEMENT which gives good service may be made by treating asphalt 12 parts, rosin 10 parts, gutta percha 40 parts, in a bottle standing in boiling water, with 60 parts petroleum. The thick mass is allowed to cool. Then add 150 parts sulphide of carbon and allow the whole, frequently shaking it, to stand several days. The belt ends or plies, evenly coated with the cement, should be exposed to heavy pressure between hot rolls.

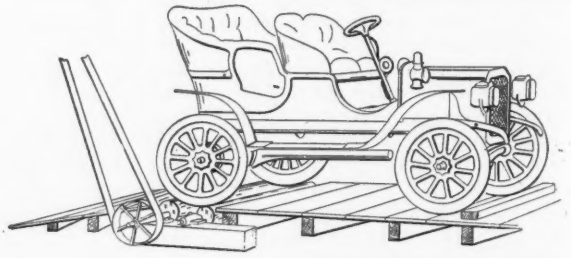
FIFTY DOLLARS A MONTH was the saving in one plant from equipping a pair of engines with continuous oiling system, shields, tank and filter.

POWER ON THE FARM

OF LATE the horseless farm has become a scare word of some papers and the gasoline engine is making big inroads, to say nothing of the work of steam plows and traction engines and electric motors where current is available. The latest wrinkle has been devised by an ingenious southerner who makes his automobile supplant his horses not only for travel but in place of the old horse treadmill.

When it isn't chugging about the place or to mill and to market the machine is stabled on a platform with the rear wheels resting on rollers, on the shaft of one of these being a pulley which drives a counter shaft. From this shaft, cream separators, churns, a wood saw, feed cutter and "sich" are driven as wanted. The rollers equalize the wear on the wheels and the differential and the grip between these and the rubber tires is sufficient to transmit all the power required.

Here is a portable 20 hp. plant turned into a stationary plant in a jiffy and the only thing needed is a governor when the load is unsteady. The small boy of the farm is ever ready to take this position at the throttle.



THE AUTO AS A STATIONARY POWER PLANT

In his description in the American Machinist, S. C. McKeown states that the auto skids from side to side when running on the rollers, but this is overcome by buffers which limit the side motion of the car.

TO FIND THE PROPER weight of an engine flywheel, multiply 240 by the mean effective pressure in the cylinder by the square of its diameter in inches and by the stroke in feet, and divide the product by the diameter of the wheel multiplied by the number of revolutions a minute.

THEORY VS. PRACTICE

AS TOLD BY THE CHIEF

SOME time ago—of course everything always happened some time ago—I was employed as engineer in an office building in the Windy City and had recently hired a young man as assistant engineer who was reveling in his first stationary license and to back it up and give good weight was also staggering under the burden of a diploma from some technical school. He was never tired of discoursing about his vast experience and the knowledge that he had (or thought he had) and when I hired him I really did so with regret that he had to take service in such a menial position. He really ought to have been in my place or been chief engineer of the Bull-Con estate on Bluff Street.

Well, the eventful Monday morning came on which he was to start in, and with a bundle under his arm he entered the engine room and looked around for a "closet" in which to hang his hat and top coat. I noticed that as he came in he had a bundle under his arm and assumed, of course, that he had his working clothes, but when he came out, My! the rest of the engine room force dropped their work and stared. He had stowed his whole outside suit in the locker and was resplendent in white duck from top to toe and a pair of the prettiest yellow gloves you ever saw. Evidently he meant to have neatness about his work.

I put him overhauling an upright engine that was driving a fan for ventilating the offices through an air shaft and he did comfortably well in rebabbitting the boxes because I turned loose with him a good husky roustabout for a helper. After about 3 days that engine was ready to run; and it really did run and run fine, and I began to think that he was a good deal like a singed cat, a long site better than he looked.

On the morning of the second day he brought with him to work his technical school diploma and his license, both nicely framed and had hung them in a conspicuous place in the engine room so that he was really part of our force.

We were begining to get used to his eccentric togs and to consider him as part of the outfit, when, on the fifth day, which was a hot one, word was sent down from the office for some ventilation. The fan engine that he had babbitted was duly started and had been running about an hour when word was again sent down for more air and I sent the assistant up to see what was the trouble. He came back and reported the engine and fan running nicely, and I began to think that some of the office clerks had been out late the night before and were probably in "bad spirits." It looked as if the office boy was out of a job and they were sending him down with kicks just to keep him out of mischief.

We had one clerk who was a born kicker anyhow and always complained of the cold. He wore one of those high standup turndown collars about 2 sizes too small for him and 3 sizes too high. When it got too dirty on one side he reversed it, and when the shiny side touched his neck he thought he was cold. He did have a long neck and the collar he wore would have made a good cuff for an ordinary man. He was one of those fellows who would go to a bakery lunch counter and get a glass of cold milk and rolls when the weather was down to 10 below zero, then come back and complain that he was chilled all through.

On the other side of the fence was the chief clerk who weighed about 200 lb. and ate a square meal for luncheon every day. He was always too hot and got hotter kicking about it, so between the 2 clerks it was a combination that made it interesting for the engineering department.

Before long, however, the other tenants began complaining about getting no ventilation, so it looked as if there was something really the matter and I started out to investigate for myself. There was that engine buzzing along as nice as anyone could ask for and the fan was humming away at a great rate. I couldn't understand what was the trouble as everything seemed to look all right, but on testing out there seemed to be no suction into the fan inlet. Nosing around the engine I discovered that our friend had set the eccentric so that the fan and engine were running in the wrong direction and the fan was, therefore, blowing no air whatever into the air shaft and as it couldn't get air out it was doing nothing.

A few days after this we had to take off the bonnet of a 12-in. globe valve on top of one of the boilers, and as it was a nice warm place I thought it would be a good chance for the high stepper to warm up his fine white trousers, so I put him on the job. That bonnet was held down by 36 ½-in. stud bolts and the nuts were rusted on. They had been there a number of years and after taking a moment to look at them down comes Mr. Whiteducks and carries up a good big monkey wrench.

We heard nothing more from him and in about an hour down he came with several spots of grease on his prettiness and considerable real sweat streaming down his face and said that the nuts were rusted on the studs and he had twisted half the studs in two.

For the benefit of those young engineers who do not know how, in this kind of case, I want to say that after giving reasonable pull with the wrench if it fails to come don't twist the stud in two but take a sharp cold chisel and split the nut, as this can be done in a few minutes, but drilling out 18 studs in a hot place over a set of boilers is no child's play.

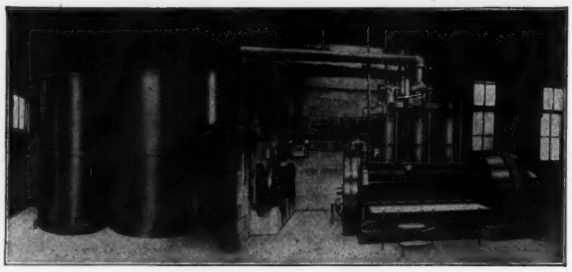
We wanted to use that steam line in about 5 hr. from the time he started to work on it. He worked 1 hr. and it took 2 men 18 hr. to finish the job.

Now this youngster was well posted on the theoretical end of matters, but what he knew about practical running of a steam plant wasn't worth knowing. I certainly admired his nerve in tackling the job but I told him I was going to take care of him and as he was a peaceable boy and willing to learn after he found that he didn't know it all, we exchanged views often on practice and theory and the combination worked well together. I learned some things I didn't know and he learned a lot that he had never heard of and eventually proved himself to be a first-class man.

ON MAY 1 THE Magnola Metal Co., of New York City, removed its Montreal office from 31 St. Nicholas St. to a new office and factory at 223 St. Ambrose St. This factory and the office will take care of the special requirements and the growing business in Canada, and has been provided particularly for the convenience of Canadian patrons.

SLOTH MAKES ALL things difficult, but industry all things easy.—Franklin.

Gas Producers



And Engines

GAS ENGINE VALVES AND VALVE GEAR

IN THE ARRANGEMENT OF valves of gas engines the problem is quite different from that for the steam engine not only as to the way in which the working fluid is admitted to the cylinder, but also the nature of the fluid and its action on the valves and seats. In the steam engine a considerable period of admission is usually desired and the length of this period is the most common point of control for the speed regulating devices.

In the gas engine, on the other hand, the admission is practically instantaneous, or the time over which it extends is very brief, and the control is by entirely different methods. The working fluid is a mixture of air and gas which has more or less dust and frequently impurities mixed with it, and particularly on the outlet of the burned gases there is likelihood of cutting and clogging in the valves. It is, therefore, impossible to use a valve which has any sliding contact and the result has been the adoption of the poppet style of valve almost exclusively, a valve which lifts straight up from its seat to open, and closes by dropping straight back upon the seat.

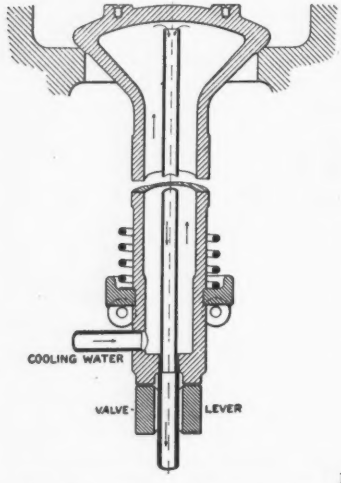


FIG. 1 MUSHROOM FORM OF VALVE, WATER COOLED

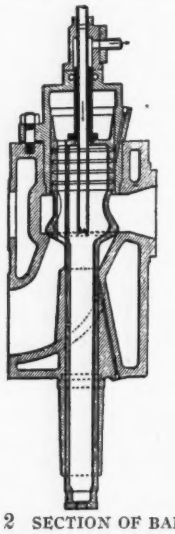


FIG. 2 SECTION OF BALANCED EXHAUST VALVE

Valve Uses

THREE kinds of valves are used in the gas engine, the inlet, the exhaust and the mixing. In the mixing valve air and gas or gasoline vapor are thoroughly combined to form an inflammable mixture which is then passed through the inlet valve to the cylinder. Rapid combustion or explosion then takes place, followed by the expansion of the hot gas and then the outlet through the exhaust valve. The mixing valve, which handles only the cool air and gas, can be of any type and is sometimes made of poppet form and sometimes in the form of 2 cylinders, one within the other, with registering ports, the proportions of the mixture of air and gas being controlled by the amount of port opening for the respective fluids, as in the Meriam engine.

While all valves are of the poppet type, the details vary considerably. For small engines the disk either flat or curved is in common use, the seat of the valve being usually a 45-deg. cone. In some cases a flat seat is used, but is found more difficult to construct and to keep tight than the conical seat. For larger engines the mushroom type of valve (Fig. 1) is more common and is frequently made with a hollow stem having an internal tube which supplies water to the interior of the valve for cooling it. In some instances the valves are made with double disks to secure a balanced effect, but this is not ordinarily considered necessary.

Driving Mechanism

IN driving the valves, cams, eccentrics and the suction of the piston are used, the last mentioned form being only for small engines of the simplest type. For engines of large size, positively driven valves are used and as the motion required is usually an irregular one, both as to opening and closing, the cam is the favorite form of driving mechanism.

In the largest of modern gas engines the eccentric is used and the irregular motion is secured by the placing of the fulcrum of the lever which acts on the inlet valve stem.

As a rule valves are held closed by a coiled spring and are opened by pushing on the end of the valve stem. This gives a simple method of providing lost motion to give dwell, and avoids the binding of the stem in its bearing. The stem is made long to give a steady action and prevent side play.

As to arrangement of valves with respect to the cylinder, designers differ greatly in their preferences. In order to drain the cylinder where there is any likelihood of moisture coming over with the gas, the exhaust valves are often placed at the bottom, and for the same reason, viz., that any moisture or tar collecting may be carried forward into the cylinder, the admission valves are often placed at the top.

Valve Arrangement

FOR vertical engines the valves are mounted directly in the heads in some instances and in other instances are mounted in cages at one side of the cylinder. For horizontal engines the valves are usually

placed at one side of the cylinder or in a bonnet which takes the place of the cylinder head. Both valves on top, both valves on the bottom, valves opposed at top and bottom or at either side all are found as the expression of some one's best judgment or sometimes as the best compromise that can be effected to use a desired form of valve gear.

While a certain amount of clearance is necessary in a gas engine to avoid over-compression, this clearance is best carried in the end of the cylinder and not in the valve casing or bonnets. For this reason the arrangement of valves should be such as to cut the clearance in the valve casing down to a minimum. Valves should be so placed as to give free inlet and outlet to the gases and arrangements should be made so that the valves can be easily removed for examination, regrinding or repairs.

Valves with the stems vertical are usually chosen rather than those with the horizontal stems, because the wear on the vertical stem is less and does not tend to get the valve out of position.

In the arrangement of ports and passages choking of gases on entering the cylinder should be avoided, because any pressure lost in getting the gases into the cylinder must be made up by a higher compression.

Dimensions of Valves

AREA of the valve should be so designed that the average rate of flow of gas does not exceed 120 ft. a second, while the exhaust valve should allow for a mean flow of gases not greater than 80 ft. a second, assuming that the gas is discharged at atmospheric pressure. It is best to say, however, that these speeds for inflow and outflow are sometimes exceeded in large engines such as used for blast furnace work and in very small engines running at high speed, such as automobile motors. Lift of the valve should not be more than ¼ its diameter, otherwise the gases will be choked on entering and leaving the cylinder.

Goldingham has investigated the dimensions of valves for gas engines and in his work on The Gas Engine in Principle and Practice he gives the following dimensions for the valves: Taking the diameter of the port, supposed to be circular, as a basis, the thickness of the disk head for a curved type disk is 0.15 of the port diameter; for a flat disk the thickness of the head is 0.1 the port diameter, the width of the conical surface on which the valve seats is 0.1 the diameter plus 0.16 in. the diameter of the valve stem is 0.125 times the diameter plus 0.2 in.

For valves which are positively driven by means of a cam the closing springs should allow about 1 lb. mean pressure per square inch of the valve. For an inlet valve which is opened by the suction of the piston the mean pressure required to open it should be less than ¾ lb. per square inch of valve; the spring must, of course, be strong enough to close the valve, but the pressure should not be great enough to choke the incoming charge. This usually requires cut and try adjustment for each individual spring, as the strength of springs is likely to vary to a certain extent.

Balancing, particularly of the exhaust valve, Fig. 2, is desirable where the valve has to operate under high pressure. In the case of the inlet valve it seldom opens under a high pressure and when it closes the pressure is also low, hence the need for balancing is not great. In the case of the exhaust valve it frequently opens when the pressure in the cylinder is as high as 35 lb. to the square inch, so that balancing is desirable.

Setting

AS to the setting of the valves with respect to the crank position, 2 sets of conditions prevail. In one there is the nonscavenging type where the gases are supposed to be forced out of the cylinder during the exhaust stroke; in the other there is the scavenging type in which the incoming charge is intended to perform the last of the cleaning out of the burned gases.

For the nonscavenging engine, as shown by Fig. 3, taken from Goldingham, air inlet is set to open at D from 5 to 8 deg. after the crank pin has passed the inner dead center and the air inlet closes at C from 5 to 20 deg. after the crank pin has passed the outer dead center. This gives a low suction and insures that the cylinder will be filled with the charge. Exhaust opens at B from 30 to 60 deg. before the crank reaches the outer dead center and closes at A from center to 15 deg. after center. In some engines the exhaust valve is opened for slightly longer time and in some cases for slightly less.

If a gas valve is used it will open at the inner dead center and close about 15 deg. before the crank reaches

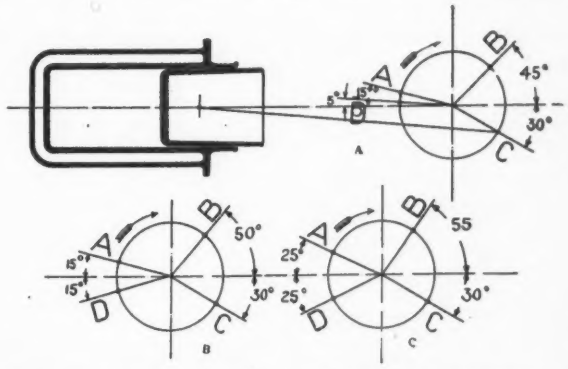


FIG. 3 SETTING OF VALVES; A AND B FOR NONSCAVENGING TYPES, C FOR SCAVENGING TYPE

the outer dead center, so as to have the charge of gas and air thoroughly mixed.

For the scavenging engine the air valve is opened somewhat earlier than with the nonscavenging type. It opens some 15 deg. before the crank reaches dead center and the exhaust valve remains open until after the air valve is opened, thus allowing the momentum of the gases in the exhaust pipe to form somewhat of a vacuum, drawing from the cylinder the burned gases. This is particularly desirable when the gases burned are of low heat value, making high compression necessary, and tends to avoid premature explosions and back firing.

CONTRACT HAS RECENTLY been let to the Vilter Mfg. Co. of Milwaukee, by the Christie Engine Co. for the construction of the first Christie Corliss Air-Steam engine, which will be of the improved Vilter horizontal type with 2 cylinders set tandem. This engine will be installed in Waterloo, Iowa, as soon as it has been completed and complete tests made upon it. It will be built for a steam pressure of 200 lb. and for a speed of 125 r.p.m. Each cylinder is to have a diameter of 14 in. and a 36-in. stroke, with poppet air inlet valves in each cylinder head. Driving engines with a mixture of steam and air is a new process and the outcome of experiments made with this engine will be watched carefully by all steam users and steam-engine builders.

HAPPINESS IS A by-product of industry.

GAS ENGINE GOVERNING

IN GOVERNING any engine the problem is so to adjust the power generated by the engine that it will be the equivalent of the load to be carried. If the load is greater than the power developed, the engine must slow down. If the load is less than the power developed the engine will run away.

Principles of Action

FOR different kinds of engines different methods of governing are adopted. The typical methods which are used are, first, the omission of working strokes. This method is not applicable in the case of steam engines because the engine draws from a steady source of power so much as it may need for each stroke.

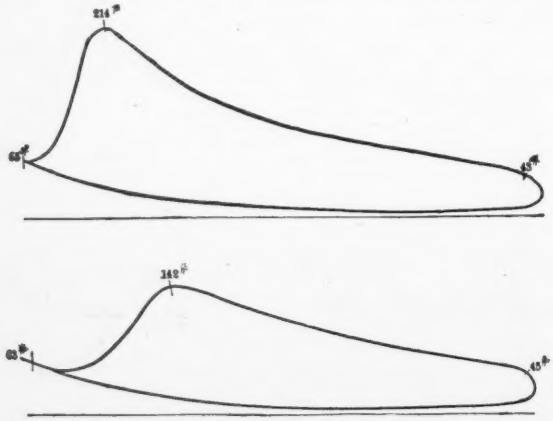


FIG. 1 EFFECT OF DELAYED IGNITION

In the gas engine, however, the entire amount of power developed by a charge is at once given to the engine and the only way to cut down power is to change

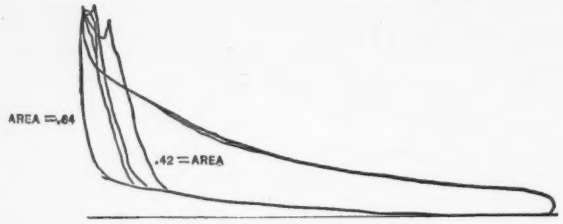


FIG. 2 ADVANCED IGNITION EFFECT

the charge supplied or omit a charge. This method of governing, called the hit and miss, is not as desirable from a speed regulating standpoint, as some others for the engine must get a violent impulse which will force the speed up, and it will then slow down until the speed has changed so that the governor will permit of another impulse. In a case where the engine is running loaded very light this means a quite perceptible variation in speed, if the engine be of the single cylinder arrangement.

Varying the strength of the charge while taking a charge each cycle is the second general method of governing. The strength may be varied either by cutting down the amount, while keeping the quality the same, or by cutting down the quality while keeping the amount of charge the same, or by varying both amount and quality. A third method which is used in smaller engines to a limited extent is changing the time of ignition.

When governing by varying the charge, if the amount of the charge be cut down, the compression pressure will be lowered. As the efficiency of an engine depends upon the compression pressure there is an objection to this from an economic standpoint, and also, as the compression pressure falls, at very light loads a point may come where the mixture will be hard to light in the cylinder and explosions are liable to be missed.

When varying the strength of the mixture, while taking a constant quantity, the compression pressure is always the same, but the temperature at which the mixture will readily ignite increases with the impoverishing of the mixture, i. e., a poor mixture requires a higher temperature than a rich one. Also the pressure generated

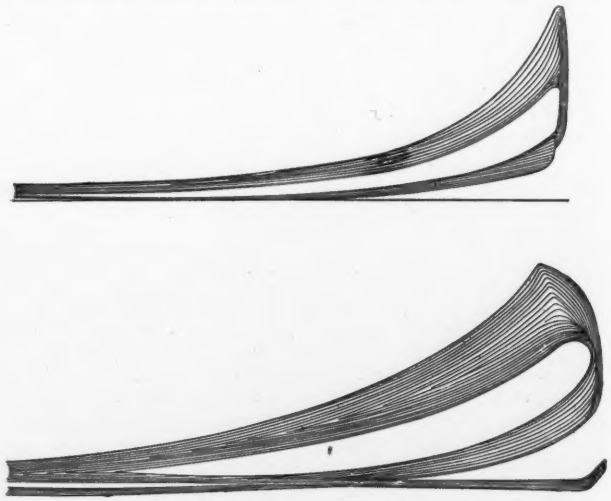


FIG. 3 DIAGRAMS WITH CUTOFF VARIED

in the cylinder by combustion will be lower with a poor mixture than with a rich one, both effects tending to lower the efficiency of the engine. It works out, therefore, that for governing at somewhere near full load, the method of changing the amount of the charge is more economical and holds the engine better to speed, while when running at very low load the hit and miss method of governing is more economical.

In some of the later designs of engines arrangements have been made so that this principle is adopted, viz., governing at loads down to one-half the rated capacity is by throttling the charge, thus reducing the quantity, while governing at very light loads is by the hit and miss method.

Methods in Detail

AS TO the detail of the hit and miss method, this may be accomplished either by cutting off the fuel supplied during any number of cycles, or it may be, as is usual in the case of the smaller gasoline engines, accomplished by holding open the exhaust valve so that no charge is drawn into the cylinder. This method is applicable only to those engines where the inlet valve is operated by the suction in the cylinder.

Varying of the charge as to amount may be accomplished either by the use of a throttle valve in the inlet pipe or by a regular cutoff valve much the same as used on steam engines, and for varying the richness, the throttle valve or the cutoff valve, either one, may be used in the gas supply. The throttling method may also be applied to the exhaust giving a high back pressure and retaining part of the burned products in the cylinder.

This gives a hot cylinder all the time and the retained

products of combustion serve to dilute the incoming charge. Also the high pressure at the beginning of suction and the cylinder partially filled with gas keep the force of suction less throughout the intake stroke, so that the charge drawn in is less.

Varying the point of ignition is a method not to be recommended. If the ignition be delayed in order to cut down the power, as much of a charge of fuel is taken in as would be the case were full power exerted, but it is burned late in the stroke, so that only part of this effect is utilized. On the contrary, if ignition be advanced in order to cut down power, it means simply that the back pressure is greatly increased and in either this case or the previous one the engine will use nearly as much fuel when running light as when running at full load. The difference in action of the 2 methods is shown in the diagrams, Fig. 1. The methods already mentioned are used for the 4-stroke cycle engine, and for the 2-stroke cycle the throttling engine is most frequently used.

Mechanism Employed

DETAIL of governors varies, of course, with the method of governing. For the hit and miss type the most common mechanism is the pick blade in which a pointed lever is used to drive the inlet valve and the governor controls the position of this blade so that, when it is desired to miss a cycle the point is swung over until it no longer engages with the valve stem. The same detail is used where the exhaust valve is held open but the blade is then fixed, arranged when it is thrown over by the governor rising to a high speed position to catch the exhaust valve stem and hold it open.

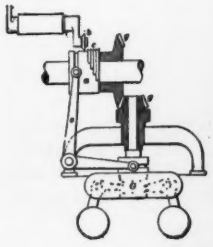


FIG. 4 DIFFERENTIAL CAM AND GOVERNOR TO CHANGE VALVE OPENING

In some types of engines the valve is driven by a cam working against a roller and the governor swings the roller to one side so that it does not engage the cam. For varying the strength of the charge a damper is usually placed in the inlet pipe or a piston valve arranged to throttle by changing the size of the ports through which gas and air are admitted. These valves are placed before the inlet valve to the cylinder proper.

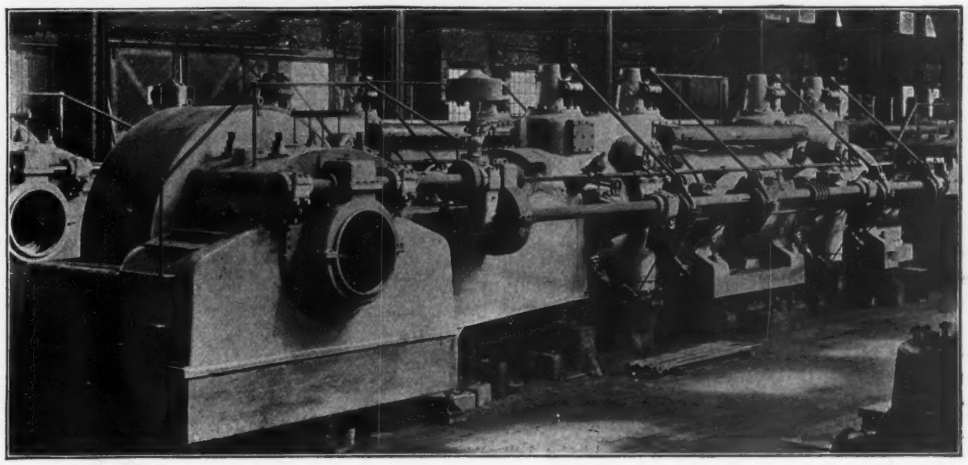
Advancing or retarding the ignition point is accomplished usually by changing a commutator which makes contact for the ignition circuit on the lay shaft. This is, of course, under control of the governor unless it be, as in the case of automobile engines, hand controlled. In governing by throttling the charge, it is better to vary the ignition point also, advancing it for light loads and retarding it for heavy ones; this is carried out in a number of stationary engines.

DETAILS OF VALVES AND GOVERNORS

ALLIS-CHALMERS ENGINES

ON Allis-Chalmers gas engines the valve gear used is of the selective stratification type so that it can be arranged for either constant compression or constant mixture. For producer and blast furnace, the first method is employed, while for natural gas, with its higher heat value, use is made of the second. As operated on ordinary producer gas the valve arrangement is such as to give practically a constant compression on loads above 50 per cent while below that point the proportions of gas and air remain more nearly constant.

Valve gears on a tandem gas engine are operated by 4 eccentrics on a lay shaft which has a rotative speed 0.5 that of the crank shaft. This is driven from the crank shaft by means of 2 sets of spiral gears. The admission and exhaust valve for each end of each cylinder are operated from a common eccentric, and as seen in the illustration, the valves are opened and closed by means of rolling cams connected by rods to the eccentric. After being once properly set the valves do not have to be changed.



THE ALLIS CHALMERS GAS ENGINE, VALVE-GEAR SIDE

The inlet valve is located at the top of the cylinder and is carried in a cast-iron cage. This arrangement makes the removal of the valve a simple process. The admission valve is of the double beat poppet type. The air duct connects to the lower section of the distribution chamber, while the gas duct connects to the upper. The upper section of the valve is made with lap and on the opening of the valve this allows air to be drawn into the cylinder first, thus exercising a scavenging effect and extinguishing any flame which may be left. Similarly on closing, the gas valve closes first and the air carries any mixture of gas into the cylinder, leaving no explosive mixture in the distribution chamber.

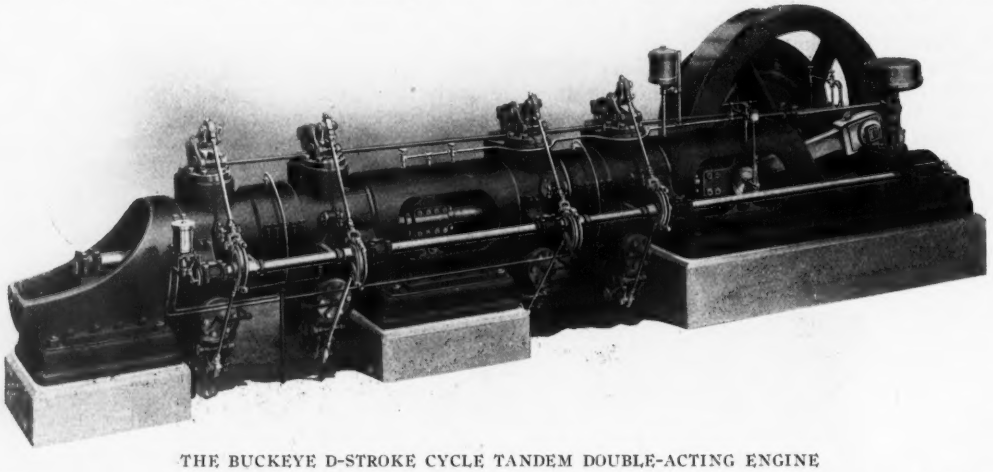
The exhaust valve is an ordinary poppet valve water cooled, which is not different from most such valves.

The speed regulation or governing is accomplished through the action of auxiliary gas and air valves on each cylinder, which are operated from a centrifugal governor through suitable shafts and rods. These valves are balanced and serve to control the relative proportions of gas and air that are admitted to the

distribution chamber while keeping the total amount constant. For use on natural gas a slight change is made in these valves to adapt them to the gas.

The Buckeye Engine

ON this the valves are driven from a lay shaft placed in the horizontal plane passing through the center line of the engine, and this shaft is driven by a set of steel gears, one of which is mounted on a crank shaft which is driven by the main crank pin through a universal joint. By this construction smooth running is obtained, even if main crank shaft and drag shaft are not in perfect alignment. On the drag shaft is a bevel gear meshing with a pinion on the governor spindle and the gear box for these 2 sets of gears is self-contained, enclosed, and provided with automatic lubrication.



THE BUCKEYE D-STROKE CYCLE TANDEM DOUBLE-ACTING ENGINE

Admission valves are located at the top of the cylinder, and exhaust valves at the bottom. In order to thoroughly mix gas and air, apparatus is used which is constructed to give complete mixture of the gases so as to give the best burning economy.

Governing is effected by weakening the charge as the load falls off until the load is about ¼ the maximum. After this point is reached, the quality is no longer varied, but the quantity is cut down as the load falls off, by throttling the mixture as it enters the cylinder. In each mixing chamber is a gas valve which shuts off the gas completely except during the period when the combustion chamber is being charged, thus preventing surging and the fluctuation of mixtures through the piping system of the engine.

Exhaust valves are of poppet type, water cooled internally.

Valve driving is effected by means of a separate eccentric for each pair of admission and exhaust valves, these eccentrics being clamped to the lay shaft. They are turned spherical on the outside and adjusted by means of a clamp joint, an adjustment which requires no shiming.

The governor is mounted directly on the gear box between the lay shaft and the main crank and is driven by the drag shaft as already explained. It is of the high-speed type, spring controlled, and very sensitive, and is provided with an oil dash pot to insure the proper stability under all conditions. The Buckeye Engine Co. of Salem, O., is maker.

Capital Gas Engine

ON this engine the valve is of the disk type and admits the mixture of air and gas, this mixture being prepared in the mixer valve and the amount which passes to the admission valve being regulated by a damper in the admission pipe. The valves are located in the bonnet at the end of the cylinder, the inlet valve being arranged in a cage which lifts off and carries the lever which operates it. The exhaust valve is placed on the lower face of the cage and is also positively operated. It can be removed for regrinding through a plug located above it. The cams for both valves are carried on a side shaft which also has on the end an eccentric to operate the igniter mechanism.

Governing on the Capital engine may be either throttling or hit and miss, the throttling method being recommended for gas. The governor is mounted on a vertical shaft driven by spiral gears from the side shaft and governs on the intake of the fuel. When the balls move they operate a roller attached to the fuel valve, this roller striking a hardened tool steel cam on the side shaft to open the fuel valve and admit a charge. If the engine goes above normal speed the governor draws this roller

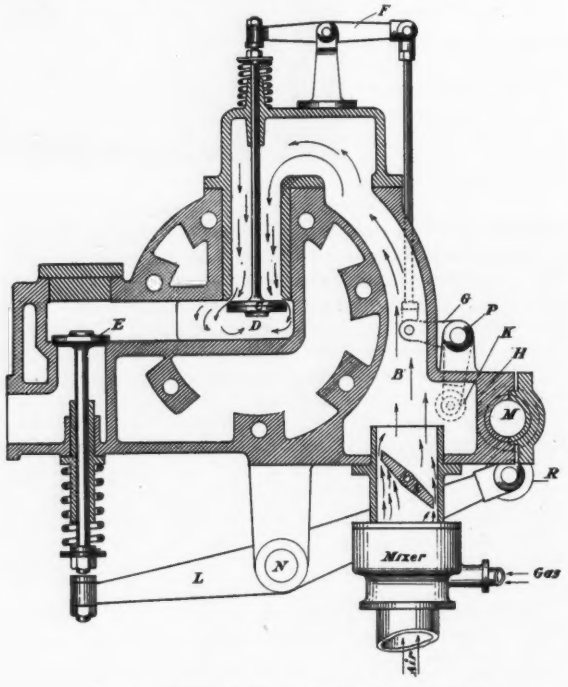


FIG. 1 SECTION OF CAPITAL VALVE CAGE

off the cam so that a charge is missed. For the throttling governor a butterfly valve is used, as shown in the cross section, and is attached to the governor as indicated in the halftone of the engine.

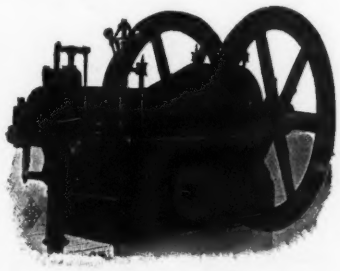


FIG. 2 35-HP. CAPITAL GAS ENGINE, WITH THROTTLING GOVERNOR

The Capital engine is made by the Capital Gas Engine Co. of Indianapolis, Ind.

Diesel Oil Engine

THE admission valve is positively opened by a lever driven from the cam shaft. This admits air for compression and at the proper time in the stroke the fuel needle valve is opened and a small amount of oil injected. The exhaust valve is also opened by cam action. Exhaust and admission valves are placed opposite each other in a box at one side of the upper end of the cylinder, as indicated in the figure, and are both of the disk type. The admission valve has its own cage which is separate from the cylinder and can be removed without disturbing the rest of the mechanism; the seat is at an angle of 45 deg. The exhaust valve seats on the casting of the cylinder with a 45 deg. seat being ground in in the usual way. The fuel valve is needle type and is fitted into a cage and water-cooled to prevent fuel from vaporizing before it enters the cylinder. The fuel valve is opened at the proper time by a bell crank lever driven from the cam shaft. All 3 valves, inlet, exhaust and fuel, are held closed by springs and are forced open by levers.

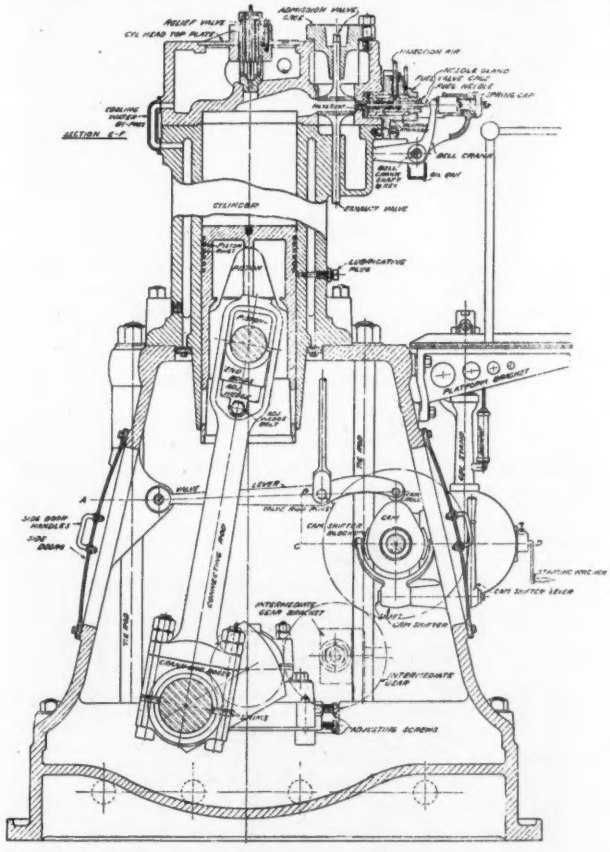


FIG. 1 AMERICAN DIESEL ENGINE, GENERAL SECTION

Governing is accomplished by the control of the fuel charge pumped into the cylinder. Fuel is furnished by a plunger pump driven by an eccentric and strap and the plunger carries a connection and rod which operates the suction valve. When the engine is carrying full load and plunger is half way down on the suction stroke, the suction valve is opened, this opening increasing until the plunger reaches the bottom of the stroke and begins the up stroke.

The suction valve remains open until half-stroke or the same point at which it opened. The object in holding the suction valve open for half-stroke is to let the air, which has an affinity for petroleum, out of the pump before delivery to the fuel valve begins, so as to deliver solid oil. The governor controls the point at which the suction valve closes.

At no load, for instance, the suction valve seats only when the fuel pump plunger is at the top of the stroke, so that no fuel is pumped into the engine.

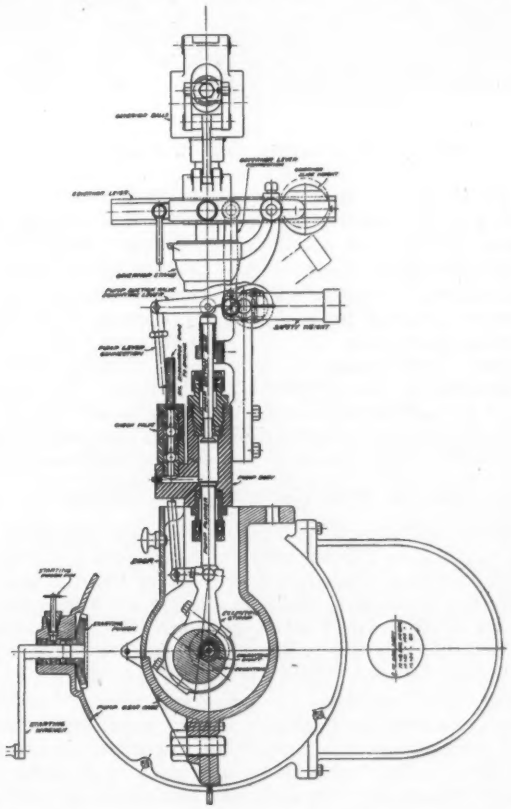


FIG. 3 FUEL PUMP AND GOVERNOR CONNECTION FOR DIESEL ENGINE

The governor controls the location of the eccentric fulcrum and in this way determines the point at which the suction valve shall close. The governor mechanism which controls governor position is of the flyball

type operating on a vertical spindle which in turn is driven from the cam shaft.

This engine is made by the American Diesel Engine Co. of St. Louis, Mo.

Cockerill Gas Engine

REGULATION of the Cockerill gas engine, which is the product of the Wellman-Seaver-Morgan Co., of Cleveland, Ohio, is effected by a flyball governor which controls the admission of the mixture of gas and air, first, by automatically cutting off or throttling the constant mixture, either of which produces variable compression; second, by varying the relative volumes

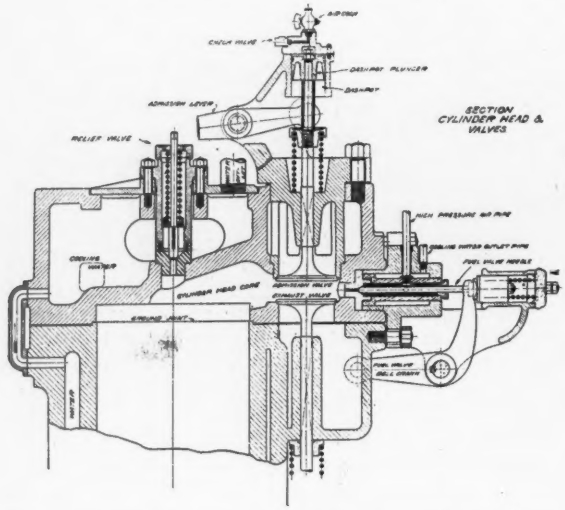


FIG. 2 ADMISSION, RELIEF AND FUEL VALVES OF DIESEL ENGINE

of air and of mixture, the latter always following the former, this method resulting in constant compression.

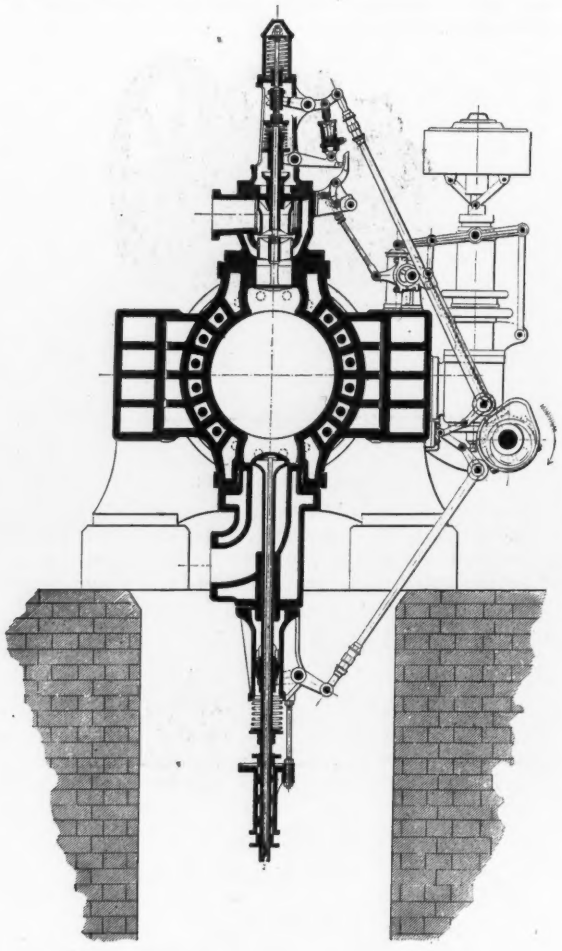
By the latter method the mixing valve remains lifted during the entire suction stroke. The gas valve opens at a certain point during the suction stroke and remains open until the end of the stroke is nearly reached. The point of opening is variable and is determined by the governor at all times. The quantity of gas admitted is in exact proportion to the load of the engine and compression remains constant. Magneto-electric igniters are provided with these engines.

The Du Bois Horizontal Gas Engine

MECHANICALLY operated valves are employed in the Du Bois gas engine, which have been carefully designed and so placed that they never become heated under any working conditions. These are 2 in number and are solid forgings fitted on removable cages which can be taken out and replaced without interfering with the piping or connections on the engine.

Du Bois engines are equipped with 2 exhaust valves, the main and auxiliary. The auxiliary exhaust is an opening called a port on the lower left side of the cylinder. This opening is not uncovered until the charge drawn into the cylinder has expended its full force and the piston has completed its expansion or working stroke. As soon as the auxiliary port is uncovered 2/3 of the exploded gases escape to the muffler, the remaining dead gases being scavenged through the main exhaust valve.

A flyball governor controls the gas and exhaust valves. When the engine reaches a speed above the normal the governor forces a latch down into an adjustable stop collar which holds the exhaust valve



VALVE GEAR OF COCKERILL ENGINE

open and immediately shuts off all fuel supply, allowing the gas and exhaust valves to remain idle and the piston to travel in the cylinder without compressing idle charges of air.

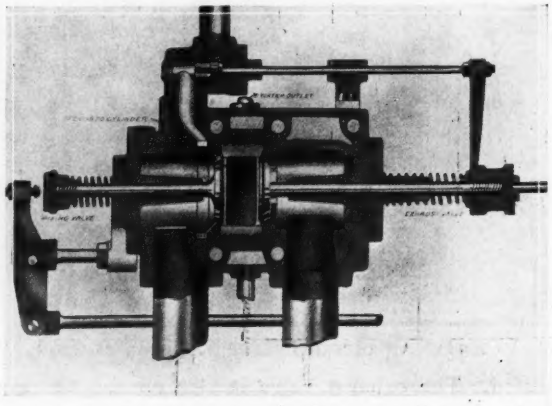
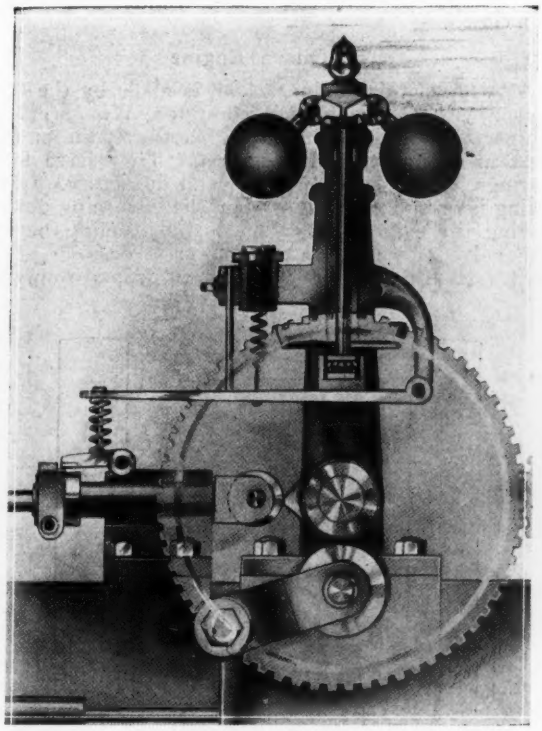


FIG. 1. CROSS SECTION SHOWING VALVE CONSTRUCTION

The device for adjusting the governor is in plain sight and consists of a spring with a swivel which

permits changing the speed of the engine while in operation. The governor itself is controlled entirely by the engine and the weight of the flyballs, as there are no springs attached to the governor balls.

Du Bois engines are fitted with an electric igniter of the make-and-break type. The entire igniter



DU BOIS GOVERNOR DETAIL

mechanism which carries the electrodes can be removed and inspected by removing 2 cap screws. Adjustment is provided so that the igniter can be set to

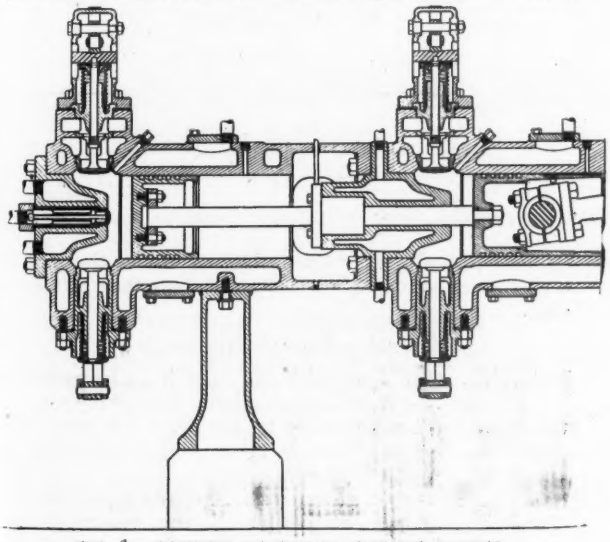


FIG. 1 SECTION OF ELYRIA ENGINE VALVES

operate on any point for an early or late explosion, according to the desired load and speed of the engine, while the engine is in operation.

These engines are the product of the Du Bois Iron Works, of Du Bois, Pa.

The Elyria Gas Engine

THIS is made with disk valves for admission, located in the upper part of the combined valve pocket and cylinder head and mushroom valves at the bottom. Both valves are positively driven from the side

FIG. 2 ELYRIA GOVERNOR AND VALVE GEAR

shaft, a single large cast-steel cam operating the valve gear on each cylinder. A relief cam is also provided, which when engaged opens the exhaust valve on the compression stroke. The side shaft from which the

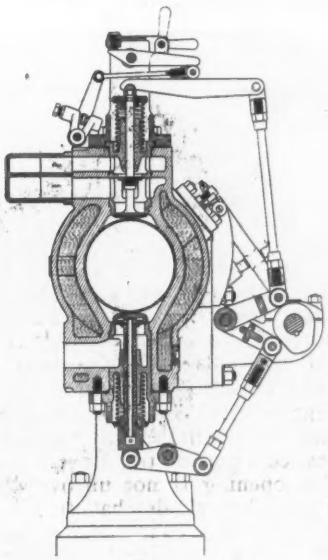
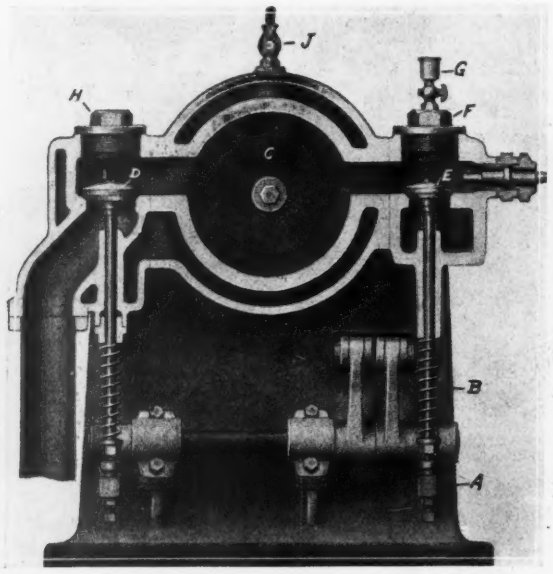


FIG. 3 SECTION OF ELYRIA CYLINDER AND VALVES

valves are driven is spiral geared to the main shaft, and drives the governor which is on a vertical shaft by 2 bevel gears.

Valves are mounted in cages, the exhaust valve having a hollow cast-iron head, shrunk to a hollow steel stem with brass tube inserted to give water circulation for cooling. The inlet valve and stem is a steel forging. Both valves are held closed by springs, and opened by push pins. The governor is of high-speed centrifugal type, varying the quantity of mixture which enters the engine, this mixture being kept of constant quality. The fulcrum point of the inlet

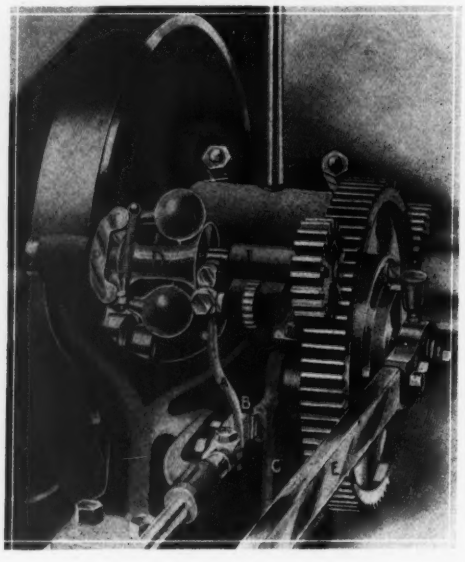


SECTION OF FOOS VALVES AND CYLINDER

valve levers is moved by a roller, thus varying the lift of the inlet valve. The Elyria engine is the product of the Elyria Gas Power Co., Elyria, O.

The Foos Engine

VALVES are located on either side of the cylinder, the inlet valve being on the right hand of the suction, as shown, and the exhaust valve on the left. Both valves

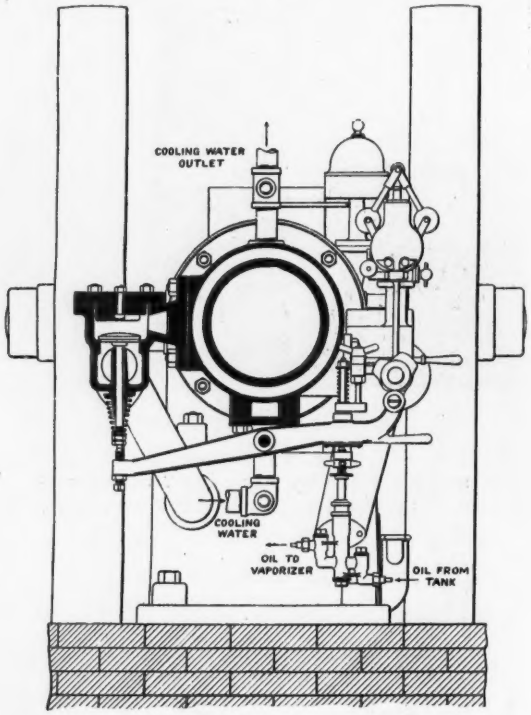


DETAILS OF FOOS GOVERNOR

are positively driven from rock shafts. In order to keep the valves in proper adjustment, screws and lock nuts are provided on the ends of the lifting levers and further wear may be taken out by shortening the reach rods which connect the lift levers with the levers running to the cam rollers. Valves are held closed by springs. The engine is governed by the hit and miss method, the governor acting to throw the pushing finger out of contact with the fuel lever, thus permitting the fuel valve to remain closed.

The Gilson Engine

VALVES of this engine, which is made by the Gilson Mfg. Co., of Port Washington, Wis., are 2 in number with ground joints and both placed in the head so as to be easily removed. They have long bearings, giving smooth action and durability. Governing is on the hit or miss plan, the governing device holding the exhaust valve open and keeping the intake valve closed when no charge is desired. The spark is also cut out until the speed drops to normal



SECTIONAL VIEW OF HORNSBY-AKROYD OIL ENGINE

again. The air valve opens by suction of the piston, and the exhaust valve is positively opened from a cam.

Hornsby-Akroyd Oil Engine

IN AN engine using a liquid fuel it is necessary to vaporize the liquid before mixing it with the air. In the Hornsby-Akroyd, made by the De La Vergne Machine Co., this vaporization is secured by injecting oil into a hot vaporizing chamber, which is heated by ignition. After the oil is vaporized, air is passed into the chamber forming a combustible mixture, and at the end of compression ignition takes place from the red hot walls of the vaporizing chamber. Air is drawn in by the piston on its outstroke and the oil is injected by a positively driven oil pump.

Valves are placed at one side of the cylinder, as shown in the cross-section view. The exhaust valve is

opened by a lever driven from the cam shaft. Governing is effected by a lever which works on a bypass valve, letting a certain amount of the oil which is displaced by the oil pump piston flow back to the reservoir. Under full load conditions the governor holds the inside valve wide open and permits the oil as thrown by the pump to enter the vaporizer, but with increase of speed the governor opens the larger concentric valve so that part or all of the oil, as may be needed, goes to the reservoir and none enters the vaporizer.

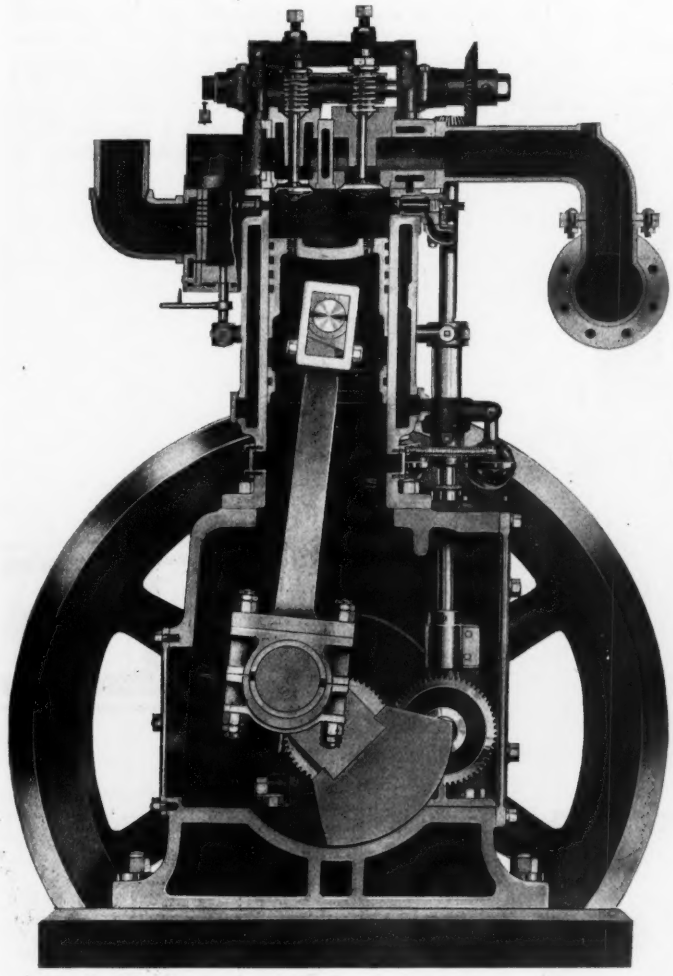


FIG. 1 THE MERIAM GAS ENGINE IN SECTION

Meriam Vertical Gas Engines

ON these engines, made by the Bruce-Macbeth Co. of Cleveland, O., valves are located in the cylinder head, both inlet and exhaust valves being mounted in cages and mechanically operated. Valves have steel stems and cast heads with conical seats. The valve stem is designed so as to eliminate thread and nut, using steel blocks instead, machined to fit the square portion of the valve stem. The exhaust valve is water-cooled through a hollow stem and this, as well as the inlet valve, is provided with extra long stem guides.

The air port is below the gas port and so arranged that some air enters the cylinder in advance of the mixture of gas and air, thus separating the new charge from the heated piston and avoiding back firing.

To drive the valves of the engine, which has 2 cylinders, a special mechanism is used on top of the engine frame. This consists of a cam shaft having cams machined directly on it, each in proper position. The cams act on rocker arms which are fitted with set screws for adjustment of the valves and these rocker arms are equipped with cam rollers, thus eliminating the use of push rods and other moving parts. This operating unit is driven from the governor shaft through a pair of steel bevel gears and the governor which is on this shaft is of centrifugal ball type. Movement of the governor balls is transmitted to the throttle mixing valve by a single lever and the whole mechanism is so arranged as to be easily removed from the engine without disturbing other parts.

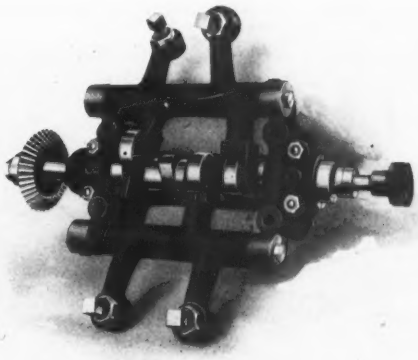


FIG. 4 VALVE OPERATING UNIT OF MERIAM ENGINE

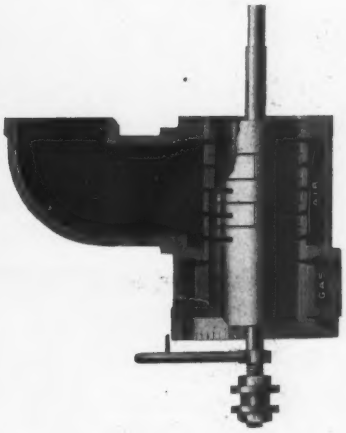


FIG. 5 MIXING VALVE OF MERIAM ENGINE

The opening of the ports in the mixing valve is regulated by the governor mechanism to correspond to the load that the engine is carrying. This mixing valve consists of a piston and sleeve mounted in the body of the valve and arranged so that the ports may match or be out of register so as to throttle as much as the case may demand; the proportions of mixture are controlled by rotation of the valve which is hand adjusted, and throttling by the endwise movement which the governor determines.

I. H. C. Engines

VALVES in this engine are arranged in the head of the cylinder. The inlet valve is held closed by a spring and opened by suction of the piston. The exhaust valve is held closed by a spring and opened by positive push of a lever driven from the cam shaft. The cam shaft is driven by a 2-1 gear reduction from the main shaft and the governing is accomplished by hit and miss as follows:

When above speed the arm from the governor balls pulls the sleeve C outward as shown. The bevel portion presses upward, then on the roller D, causing detent arm E to move downward. When the long side of the cam presses the roller at the end of the rod H outward the lever E engages a notch F, holding the exhaust valve open and at the same time the inlet valve is held closed. When the speed reduces to normal the sleeve C moves back, allowing the detent lever to disengage F and the cycle of operation is taken up again with the exhaust valve closing every other stroke. The I. H. C. engine is by the International Harvester Co. of Chicago, Ill.

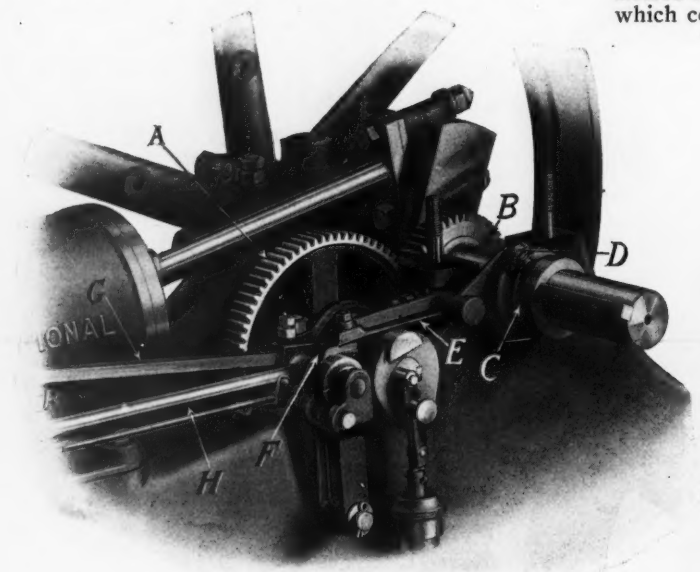


FIG. 2. DETAILS OF GOVERNOR CONTROL OF EXHAUST VALVE ON I. H. C. ENGINES

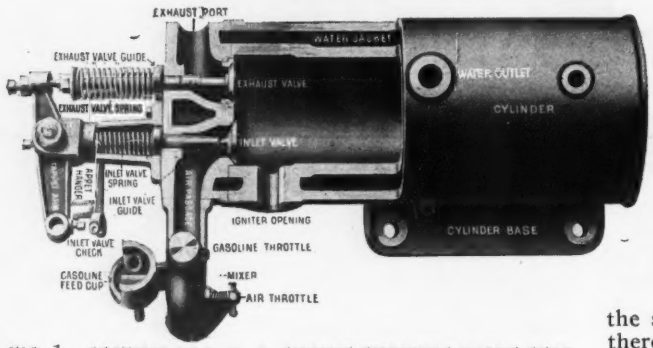


FIG. 1. SECTION OF I. H. C. ENGINE SHOWING VALVE GEAR

The Koerting Engine

VALVES in this engine are arranged in a valve chamber at the end of the cylinder, the admission valve being above and the exhaust valve below. Both valves are positively controlled and are held closed by springs, the link mechanism which operates them being driven from a side shaft which also drives the governor.

Mixing is accomplished by a double seated special valve so constructed as to be operated automatically by the incoming charges of gas and air. Gas and air enter the mixing valve at right angles, the gas coming in in a number of small streams and the mixture being passed through a set of ports which gives it a whirling motion. After mixing the combustible is admitted to the power cylinder through a throttle valve which controls the amount of fuel needed to keep up the speed of the engine. The amount of mixture is therefore measured out according to the load on the engine.

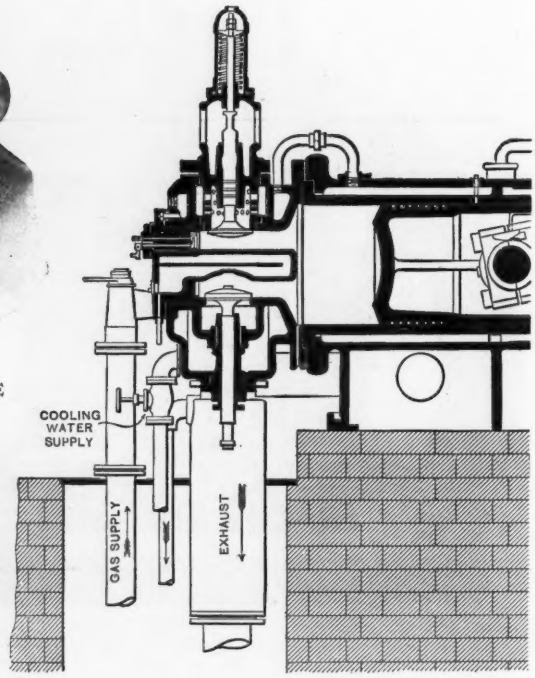


FIG. 1 VALVES OF THE KOERTING GAS ENGINE

This engine is made by the De Le Vergne Machine Co. of New York, N. Y.

Reeves Gas Engine

CONTROL of the speed of the Reeves gas engine is effected by means of a flyball spring governor. On all parts subject to wear, friction is reduced to a minimum by means of a small anti-friction block, which, together with the perfect balance, gives an exceptionally close regulation. The speed may be regulated while the engine is in operation.

A throttle valve is used consisting of a proportional valve perfectly balanced, the sides of which are so arranged that it is impossible for the valve to stick from gum. Above the air and gas ports are proportioned for different fuels. The action of this valve is

positive and gives a constant proportion of air and gas for all varying loads.

The valve stem guides on both intake and exhaust are made of cast iron inserted in the cylinder head, and are provided with an efficient method of lubrication and also water jacketed. On all engines larger than 50 hp. the valves are set in cages which are inserted in the heads and are made tight by means of ground joints. An improved system is provided for injecting cooling water directly around the exhaust valve seat.

Either the jump-spark or make-and-break system of ignition may be used with this engine, but the

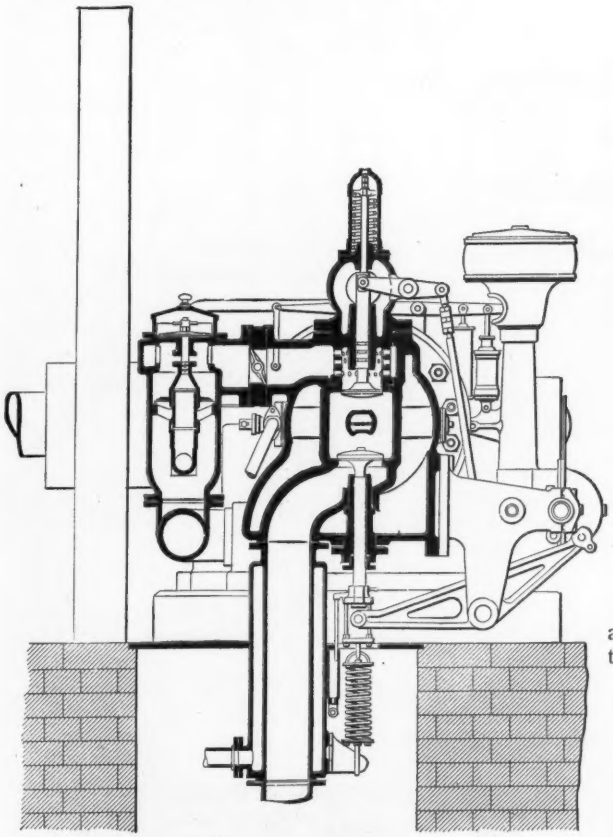


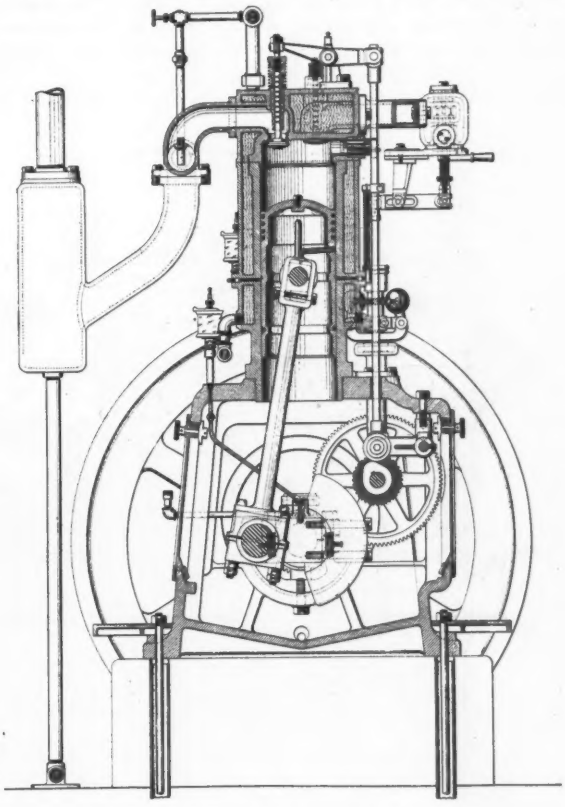
FIG. 2 SECTION OF KOERTING ENGINE SHOWING VALVES AND GOVERNOR

former is recommended by the makers when the engine is to operate on gasoline or natural gas. With this system is used a high grade coil mounted upon a castiron bracket fastened to the cylinder head in such a manner as to make the wiring simple and compact. The timer is so arranged that the firing point can be changed while the engine is in motion. The spark plugs or igniters are located directly under the inlet valve in line with the incoming gases.

When the make-and-break system of ignition is employed an igniter plate is used, set in the cylinder head by means of a ground joint.

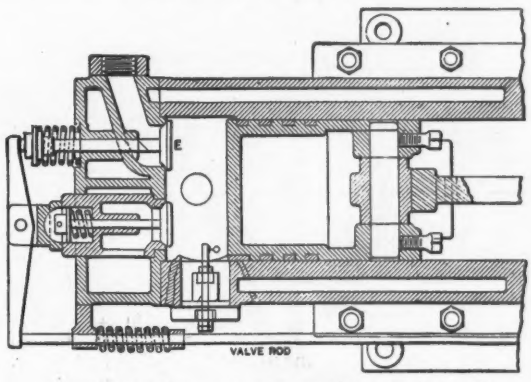
The Fort Wayne Engine

THE Fort Wayne Foundry & Machine Co. builds an engine having the valves located in the cylinder head, the inlet valve being free-opening under the action of the piston suction and the exhaust valve being opened by a push rod and lever. There is a supplementary gas valve which controls the amount of the gas supplied. Ignition is of the make and break type, operated by a pick blade on the end of the firing rod which engages with the



VERTICAL SECTION OF REEVES GAS ENGINE

arm of the igniter spindle. The governor controls the throw of the firing rod by engaging or disengaging this



SECTION OF FT. WAYNE CYLINDER AND VALVES

pick blade, and acts also on the valve to prevent the engine from taking a charge during the idle strokes.

The St Marys Engine

IN the St. Mary's single acting four cycle tandem gas engine, regulation is accomplished through a heavy centrifugal governor of the constant energy type acting on a lever which varies the position of a sliding block, allowing the valve rod to engage with the valve stem through a greater or lesser angle of its travel. Admission is through a double ported valve allowing the gas

and air to enter separately and at this point they are thoroughly mixed and enter the cylinder. The gas valve closes slightly before the air so that the valve space is full of pure air preventing any back firing. The control is by throttling a constant quality mixture at all loads. Both inlet and exhaust valves are driven by a single eccentric having a rod attached for the inlet and exhaust valve respectively.

The eccentric gives the valves a rapid opening and of course their operation is noiseless since there are no cams present to cause clicking and knocking. This engine is manufactured by the St. Mary's Machine Co. of St. Mary's, O.

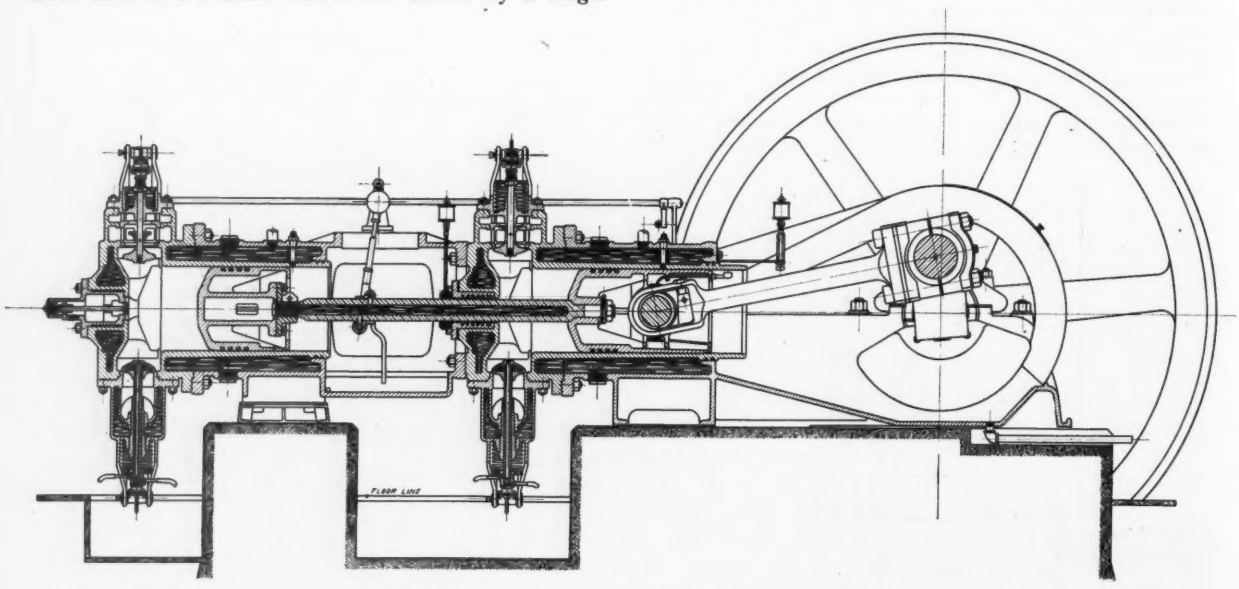


FIG. 1 SECTION OF ST. MARYS TANDEM ENGINE

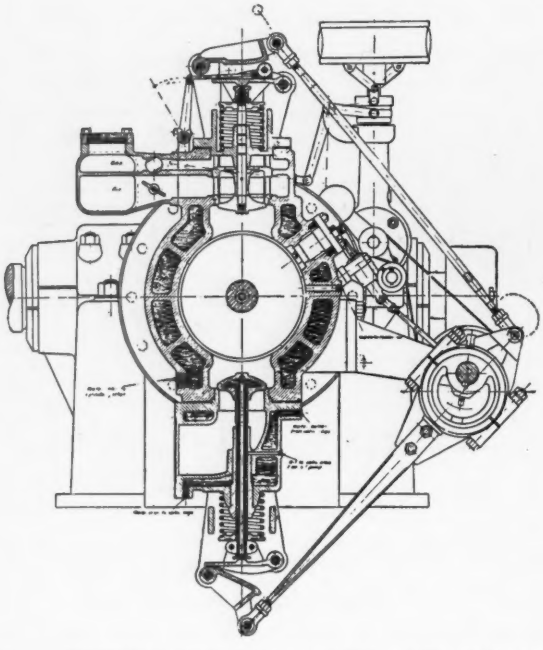


FIG. 2 SECTIONAL VIEW OF ST. MARYS VALVE GEAR AND GOVERNOR

The Westinghouse Gas Engine

FOR carrying the cams a shaft is driven from the main shaft by means of gearing, and each exhaust cam works against a roller carried on the free end of the pivoted guide lever, which bears against the exhaust valve stem; the valve is held closed by a spring and opened by the cam. To control the admission valves a cam shaft is located on the opposite side of the engine and is driven by a shaft from the exhaust cam shaft. This vertical shaft also carries the governor.

On the upper cam shaft are 2 cams for each cylinder, one engaging against a roller on the end of the horizontal lever, the other end of which depresses the stem of the inlet valve which allows the mixture of air and gas to enter the cylinder. This inlet valve is held closed by a spring. The other cam operates the igniter mechanism.

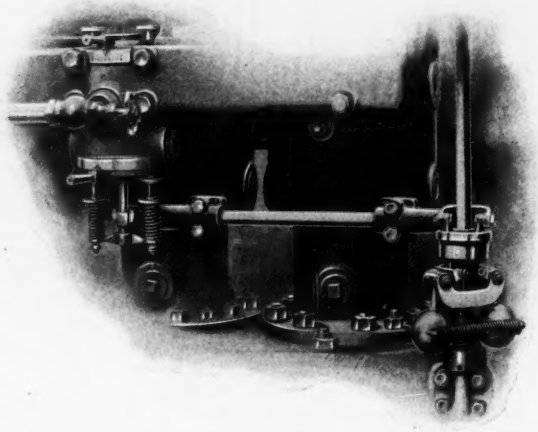


FIG. 2 GOVERNOR FOR 3-CYLINDER WESTINGHOUSE ENGINE

Regulation of speed is controlled by varying the amount of air and gas mixture admitted to the cylinder, the proportions being kept always the same. In consequence, the strength of the explosion pressure is

graduated according to the power required. The governor is located on a vertical shaft at one side of the engine, and its motion is transmitted to the regulating valve, through a rock shaft and levers. Just what proportions of air and gas shall be used are always in the control of the attendant, and he can see by the action of the governor what mixture is most efficient. The governor mechanism is of fly ball type, quick and sensitive in action.

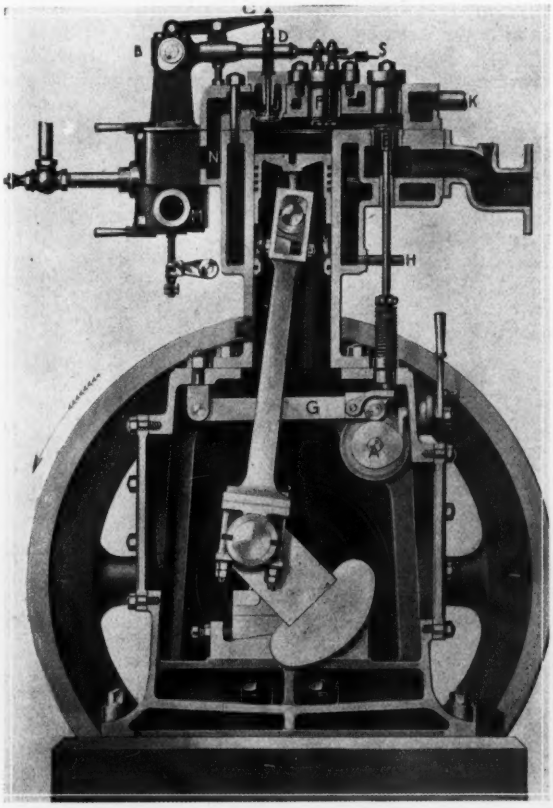


FIG. 1 WESTINGHOUSE VALVES, CYLINDER AND MIXING VALVE

For 2 engines operated in parallel to drive electrical units the slight change in speed desirable is provided for by springs on the mixing valves which can be adjusted while the engine is running, so as to alter the position of the governor. The mixing valve which controls the air and gas delivered to the cylinders is a vertical free-moving cylindrical valve with suitable ports surrounded by 2 independent sleeves having corresponding ports. These sleeves may be rotated by handles through a small arc, positions being indicated by graduated dials.

Two valves are used in each cylinder, one for the inlet and one for the exhaust, both being placed in the cylinder head. These are of mushroom type seating vertically and easily removed for regrinding. The inlet valve is seated in a bonnet cage forming a one-piece plug, and the exhaust valve, although it seats downward, may also be taken out through an opening in the cylinder head, so that none of the main parts of the engine need be disturbed in order to remove the valves for inspection or regrinding. For the larger sizes exhaust valves are water-cooled through a hollow stem with an internal concentric tube rising to the valve head.

By rotating these sleeves the best mixture for any given set of conditions is "felt out" and the governor controls the position of the mixing valve in the sleeves, thus controlling the amount of the mixture supplied. For producer gas plants or where dust and tar are found in the gas, a mixing valve of poppet type is employed which operates on the same principle. The Westinghouse engine is made by the Westinghouse Machine Co., Pittsburg, Pa.

The Nash Engine

FOR especially close regulation the throttling governor is used, and for moderate regulation requirements the hit and miss type. Either one can be set as preferred. Valves are located at one side of the

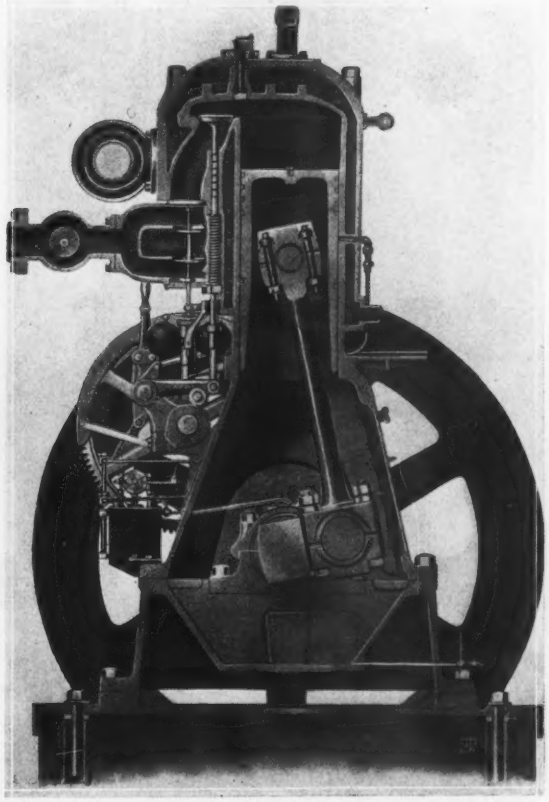


FIG. 1 SECTION OF NASH VALVES

cylinder and are of the disk type held closed by springs and opened by positive action. The guides for the valve stems are water cooled and the stems are long to insure steady running and freedom from side motion.

Governing is secured by a combination of control of the mixture and throttling, giving a high efficiency at light loads as well as near the maximum load of the engine. A side shaft geared from the main shaft of the engine carries the cams which operate the valve levers, and this shaft also drives the vertical governor shaft. On the upper end of the governor shaft is a balanced valve through which the mixture passes to the cylinders, and the position of the governor controls the position of this throttling valve. The same action controls the mixing valve, thus changing the strength and amount of the mixture supplied.

The Nash engine is made by the National Meter Co. of New York, N. Y.

Turner-Fricke Engine

IN this engine, which is of the vertical type, the valves are placed at each side of the cylinder head with water jackets completely surrounding the valve seats. These seats are small rings pressed into the water jacket body and have conical bearings for the disk valves.

The valves are held closed by springs and opened by positive action of the cam shafts, of which there are 2, one on each side of the engine. The inlet valve is situated on one side of the cylinder and the exhaust on the other, the independent cam shafts allowing of separate adjustment for inlet and exhaust cams. The governor is of the flyball type, controlling a throttling valve in the mixing chamber. It is driven by means of a pair of bevel gears from the inlet cam shaft and controls a gas and air mixing valve of balanced piston type with ports arranged so that the proper proportions of gas and air are maintained automatically under all loads. These proportions may be regulated while the engine is running by means of a hand lever. The engine is manufactured by the Turner-Fricke Mfg. Co. of Pittsburg, Pa.

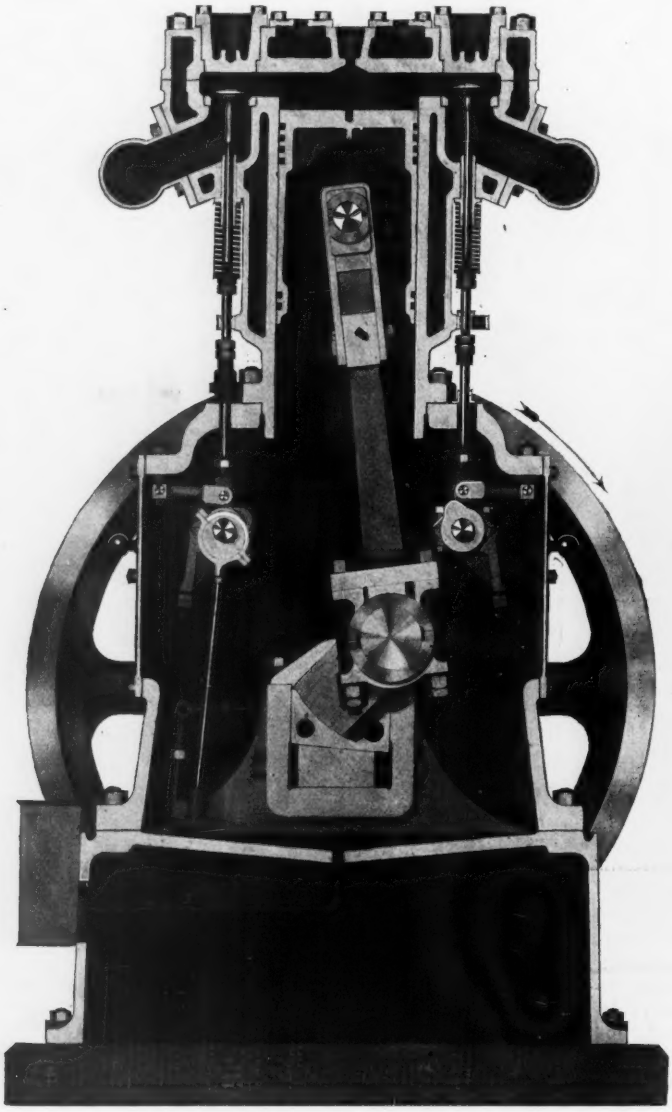


FIG. 1 SECTION OF TURNER-FRICKE CYLINDER AND VALVE CHAMBERS

The Weber Gas Engine

IN the Weber gas engine the governor is set vertical and is of flyball type, driven by a bevel gear from the cam shaft. This governor actuates a valve of balanced type which delivers the gas and air mixture in correct volume to the cylinders as required by the load. It thus measures the amount of charge fed to the cylinder without changing the quality of the mixture. This mixture is delivered by a special mixer apparatus and to suit the varying conditions of the atmosphere it is regulated by hand. Valves are forged from a single piece of steel or made with steel stems and cast-iron heads. All valves have removable seats and are ground to fit.

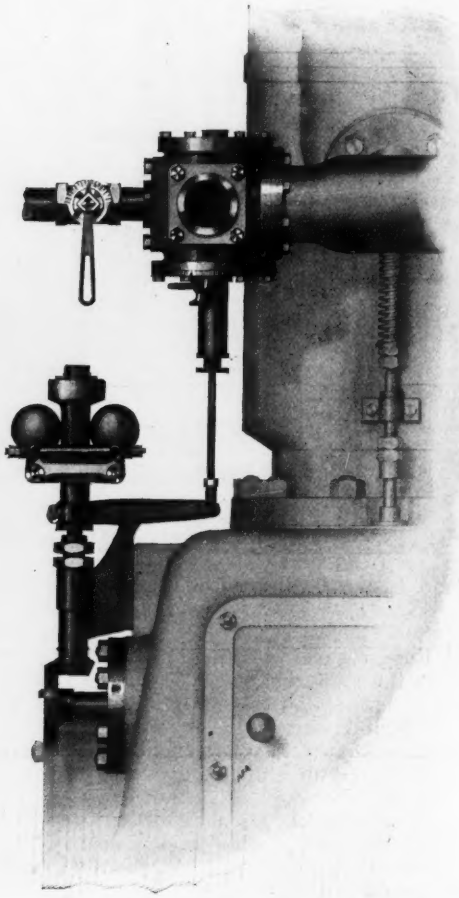


FIG. 2 TURNER-FRICKE GOVERNOR AND MIXING VALVE

A cam shaft runs inside the casing and on this are mounted cams which operate the inlet and exhaust valves by positive motion, the valves being adjustable finely by a steel disk between the valve rod

and the cam mechanism. No bolts, nuts or screw devices are used in adjusting the valves, the adjustment being made by grinding the steel disk. Valves and stems are water cooled on large engines. The valves are of disk type with heads either flat or curved, according to size.

The manufacturers of the Weber engine, the Sheffield Gas Power Co., of Kansas City, are willing to guarantee at any time a speed regulation within 2 per cent on variations of load from 25 per cent to 110 per cent. In some cases the engines have governed as close as 1 per cent, but such close regulation cannot be guaranteed. In the most recent design the governor is driven by having a rectangular recess containing 4

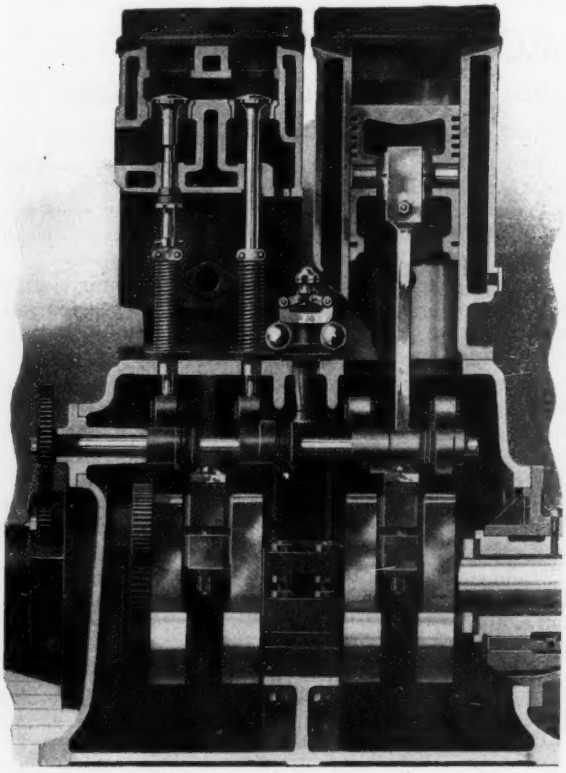


FIG. 1. SECTION OF WEBER GAS ENGINE SHOWING VALVES AND GOVERNOR

coiled springs all acting in compression. These are disposed in pairs, opposite each other with a double dog on the governor stem between the opposed pairs of springs. By driving in this manner the motion of the governor is absolutely steady and the fluttering of the governor valve is remedied. The spring drive also takes out any back lash due to wear of the cam.

INDUSTRIAL INSURANCE

DEALING with the problem of employers liability for accidents to workmen, and compensation for such accidents, a plan has been adopted by the International Harvester Co. which is noteworthy and of special interest particularly as the legislatures of many states are now investigating the subject of employers liability, and endeavoring to formulate legislation in regard to this subject.

The purpose of the Harvester Co.'s plan is to insure to employes at the works prompt, definite and adequate compensation for injuries resulting from accidents occurring while engaged in the performance of their duties. Also to provide compensation to relatives dependent upon any employe whose death results from such accident.

In case of death 3 years' average wages will be paid, but not less than $1,500, nor more than $4,000. For loss of a hand or foot, 1.5 years' wages, but in no event less than $500 or more than $2,000. For the loss of both hands or both feet, or 1 hand and 1 foot 4 years wages, but in no event less than $2,000. In cases of other injuries, ¼ of the wages during the first 30 days of disability, and if disability continues beyond 30 days, ½ the wages during the continuance thereof, but not for more than 2 years from the date of accident. If total disability continues after that time a pension will be paid.

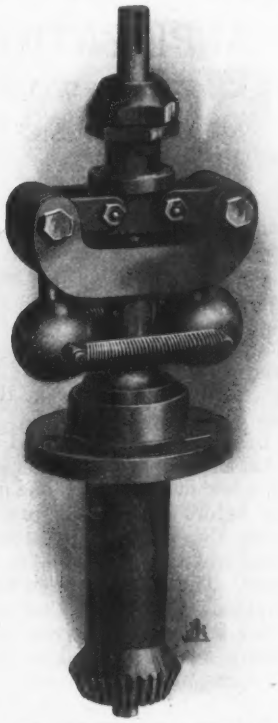
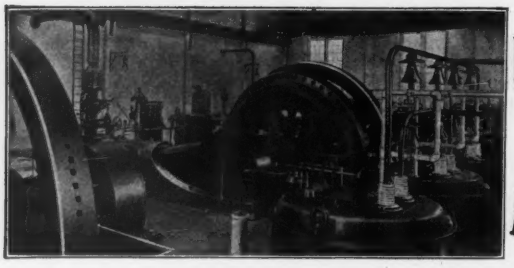


FIG. 2. WEBER GOVERNOR

Provision is made so that employes may increase the benefits to be paid during the first 30 days to an amount equal to half the wages. This is accomplished by creating a benefit fund to which employes, earning $50 a month or less, will contribute 6 cents a month, those earning from $50 to $100, 8 cents a month, and those earning more than $100, 10 cents a month. These small contributions, together with the ¼ wage paid by the company will be sufficient to provide ½ pay for all injured employes during the first 30 days of disability.

Under this plan no workman loses any legal rights of bringing suit for damages against the company, but if he decides to accept the benefits provided by the company, then this acceptance releases the company from all further liability arising out of the accident. The matter is to be handled by a special industrial accident department, which is managed by a board of managers, composed of 5 members, appointed by the company. Benefits will not be paid, however, where the injury is due to the intoxication of the employe, or to failure to utilize the safety appliances provided by the company, or to willful misconduct.

ELECTRICAL



MACHINERY AND APPARATUS

APPLICATION OF ELECTRIC MOTORS

GENERAL CHARACTERISTICS, SPEED CONTROL AND TYPICAL INSTALLATIONS

DURING RECENT YEARS THE development of electric motors has been carried on to such an extent that nearly every power driven machine or apparatus has been experimented with, and a motor to fit the special needs designed and perfected to give most economical and satisfactory results. While a multiplicity of conditions have been encountered, the development of motors has been along certain well defined lines, and as a result we have comparatively few general types of motors which require only slight modifications to make them adaptable to the most intricate special application.

In a number of industries, the demand for motors of a special nature has been so great that these motors have become standard, while in other cases one must study the conditions closely before determining just what type to install. There are always 2 limiting conditions which present themselves when it is desired to select motors for a given purpose. The first of these is the kind of current which is available, that is, whether direct or alternating current will be used for driving the motor. If alternating current is available it will be either 1, 2 or 3-phase, and motors must be selected to suit the existing conditions.

The second limiting condition and the one which requires the more study is the character of the load which will be placed upon the motor. This may in general be sub-divided into 3 classes, steady, varying, and reversing loads, and each of these classes may be sub-divided according to the speed conditions into constant or variable speed.

Direct-current motors may be divided into 3 types, series, shunt, and compound. The series motor is used where a heavy starting torque is necessary, the speed at the start is low, and where the speed regulation is not a necessary feature, as it is essentially a variable-speed motor, depending upon the load to fix its speed. A series motor should never be used where the load is apt to be taken off while it is in operation unless an attendant is always at hand to prevent it from running away. These motors are suitable for cranes, machine tools which start with a load, railway cars and the like.

Where the load is light when starting, and a thoroughly steady load is maintained or a range of speed desirable, a shunt motor is employed. Line shafts or groups of machinery are usually driven by shunt motors.

The compound motor is adaptable to a load that is exceedingly variable, and where a moderately constant speed is required. It is suitable for individual drive of machine tools and work of that class.

Special types of direct-current motors have been developed to meet the demands for a power with a large range of speed; these require special windings, or mechanism for varying the reluctance of the magnetic circuit, and where commutator difficulties are experienced, interpole motors have been used to good advantage.

Where alternating current is used the squirrel-cage induction motor with low resistance is employed for giving a constant speed and is comparable to the direct-current shunt motor in its operation.

The induction motor with a high rotor resistance gives similar results to those obtained with a compound-wound direct-current machine. Induction motors with slip rings, having external resistance are used where the load requires a variable speed, and the motor is started with a heavy torque. This class of motor has similar characteristics to those of the direct-current shunt motor with armature control.

Induction motors with self-contained resistance in the rotor are used on line shafts or group drives where a sufficient number of machines are employed to keep the load fairly constant.

Where a constant unvarying speed is highly essential, synchronous motors are employed with good results. They are generally used in motor-generator sets and similar classes of work.

Speed Control of Motors

ONE of the most advantageous features of motor drives is the ease with which they can be controlled. Where individual drive is employed it is essential that the speed of the driving power be adjustable to suit the needs of the machines and while this can be done with steam and gas engines, it is at the expense of efficiency and the means employed are not so easily handled as with electrical control.

In considering how electric motors are controlled, let us find what makes the motor go in the first place, and then by varying the conditions, one at a time, we can understand how the desired results are obtained.

When a wire carrying a current of electricity is placed in a magnetic field whose lines of force are at right angles to the wire, a mechanical pull is exerted on the wire tending to force it so as to cut the lines of magnetic force at right angles. It will be seen that the wire will go in one of 2 directions, and it will also be noticed that if the direction of the current in the wire or the direction of the lines of magnetic force is changed, the direction of the pull on the wire will be reversed, but if both current and magnetism are reversed, the pull will be in the same direction.

Another factor which enters into this operation is the strength of the pull on the wire. We find that if the wire is held still, this pull varies with the strength of the field and the amount of current flowing. Here then is a method of changing the capacity of the motor and also its speed; but when we set the wire in motion, another element enters which has not yet been considered; this is the tendency of the motion to act as a generator. We know that an electrical conductor traveling at right angles to the lines of force in a magnetic field creates an electromotive force between the ends of the wire or conductor. The amount of this electromotive force depends upon the speed of the conductor and the strength of the magnetic field, and in direction this force tends to oppose the current which causes the motion of the conductor; it is therefore called counter-electromotive force.

When a load is put upon a motor, which is nothing more than a series of these conductors, its speed becomes such that the electrical energy exerted is just balanced by the mechanical power which it imparts; the heavier the load, the slower will be the speed; the slower the speed, the lower will be the counter-electromotive force, and consequently the higher the armature current with the same applied voltage, the field remaining constant, and the greater the torque.

A study of the relations which exist in the direct-current motor as stated above will reveal that the speed of motors can be changed by varying 3 conditions, the strength of the field, the armature current and the load. As the load is usually fixed by the work to be performed it is not used as a means of speed control.

The Shunt Motor

CONTROL of shunt-wound motors is effected in 4 ways, by placing adjustable resistance in the shunt field, varying the reluctance of the magnetic circuit, placing adjustable resistance in the armature circuit, and varying the voltage by the use of the multiple-wire systems.

Where resistance is placed in series with the shunt field the speed is increased from the normal rating by cutting in resistance. For obtaining better commutation with this method the use of interpoles is necessary in the larger sizes of motors, which makes the machine comparatively large and bulky. It is possible, by the use of interpoles, to secure a speed range of 6 to 1, though 3 to 1 is the common practice. By this method the speed does not vary appreciably with load variation, which is an advantageous feature in some classes of work. The method also presents the advantage of a small amount of lost energy in the rheostat as the current through the shunt field is usually quite small. The simplicity of this method makes it a popular one wherever it can be employed. The disadvantage of the method is that a comparatively large motor with special features, such as interpoles, makes an expensive machine.

Motors controlled by varying the reluctance of the magnetic field, increase their speed from the normal rating, but maintain a constant horsepower output. There are 2 methods employed at present for varying the reluctance; one being by movable pole pieces, the positions of which are regulated by a hand wheel, this varies the reluctance by changing the length of air gap between the armature and field pole. The other method is by shifting the armature to one side thus cutting down the area of the armature core placed directly between the field poles, and by a conical shape of the armature the air gap is changed at the same time. These methods require specially constructed motors, but where considerable range of speed is required it can be obtained in this manner with efficiency.

The common method of controlling the current in the armature of a shunt motor is by changing the electromotive force applied directly to the armature, by placing a rheostat in series with it, the resistance of which can be adjusted to suit the needs of the machine driven. By this method the speed of the motor is reduced from the fixed maximum rating. The principal advantage of the method is that standard constant-speed motors can be used without special construction. The disadvantages are that a large rheostat is required, the loss of energy is considerable, except where the torque decreases with a decrease in speed, and a changeable load causes a varying speed.

The multiple-voltage control, as usually employed, is effected by the use of the 3-wire system which supplies the motor with 2 voltages, the low voltage being half that of the high voltage, and by the use of either resistance in the shunt field or armature circuits a wide range of speed can be obtained with a constant speed at half the normal rating. A great advantage of this system is that a standard motor can be employed and also the controlling rheostat is small in comparison with those of the other systems mentioned. The method, however, involves a complicated system of wiring, which may in some cases prevent its use.

Where a shunt motor has been decided upon the method of control depends largely upon the character of the load; where the torque decreases with a decrease in speed as is experienced with fans, centrifugal pumps, and the like, the armature resistance is adaptable, provided this decrease in torque is greater than the decrease in speed, otherwise this method is inefficient. Where constant torque must be supplied regardless of the speed, the shunt-field control has an advantage over the armature resistance method.

Series Motors

THE series-wound motor is essentially variable speed as when the load is light the speed becomes high, and when heavy the motor speed is low. The methods of control are that of placing a resistance in series with the motor and by use of different voltages, and the motor requires that an attendant be always at hand, where the load is apt to be taken off as the speed at no load becomes dangerously high and will result in the destruction of the motor.

Compound Motors

METHODS used in controlling the speed of compound motors are the combination of those explained for varying the speed for the shunt and series motors. This type is suitable where a moderately constant speed is required on a variable load, this being automatically controlled by properly compounding the field.

Alternating Current Motors

PRINCIPLES involved in the construction of alternating current motors are quite different from those of the direct current. These motors may be divided into 3 classes; induction, synchronous, and single-phase commutator types.

The induction motor is operated by a rotating field which induces current in the armature or rotor of the motor. The rotating field is set up by so winding the stator that the magnetic poles shift continually in one direction, around the field. The lines of force thus caused cut across the conductors of the rotor thus producing a current which reacts upon the field and causes the rotor to revolve. The speed of this type of motor is constant for any given load and is fixed by the frequency of the circuit and the resistance of the rotor winding. For controlling the speed of the induction motor therefore, the

method employed is to insert in the rotor winding a resistance which can be controlled to suit the desired conditions.

The synchronous motor is wound practically the same as the alternating current generator. The field is excited by direct current and the driving current fed to the armature through collecting rings. The speed of this type of motor depends entirely upon the frequency of the circuit, and it therefore cannot be varied, but remains constant at all loads.

The single-phase motor is commonly employed where a variable-speed, alternating-current motor is desired. There are a number of ways in which his type of motor has been arranged to give adjustable speed. It is a new piece of electrical apparatus and in all its forms it uses a commutator and has a right angle correcting or commutating field. One form is a straight series motor, wound very much as the direct-current series motor. A transformer or induction motor for single-phase current has the commutating winding in series with the armature short circuited, or with the commutating winding in series with the field and the separate armature short circuited, with the armature and commutating field short circuited separately. Another arrangement is to have the field, armature and commuting field, each operated from a separate transformer tap, so that the voltage applied to each can be adjusted separately to suit the needs of the load.

Motors Used For Pumping

ONE of the places where the induction motor lends itself most readily is for driving centrifugal pumps by direct connection. An arrangement of this sort is shown in the illustration Fig. 1, where a 2-stage centrifugal

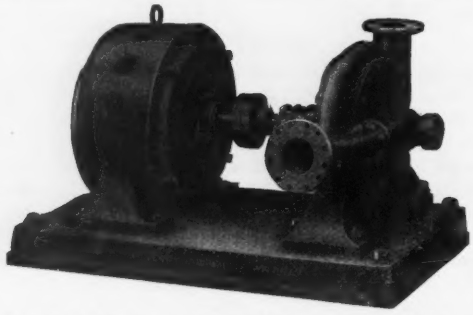


FIG. 1. TWO-STAGE CENTRIFUGAL PUMP DRIVEN BY AN ALLIS-CHALMERS INDUCTION MOTOR

pump is driven by a type A. N. induction motor made by the Allis-Chalmers Co. Here the motor and the pump are mounted upon the same base which is the only part of the apparatus which is spacial in any way.

The motor in this case is of the squirrel-cage type, wound for 3-phase currents, and suitable for all classes of constant speed service where an unusually large starting torque is not required, or where a fairly large starting current is not objectionable.

The coils used in the stator or primary of this motor are wound on forms and carefully insulated and impregnated with insulating compound before being placed in the slot. Except in the small sizes, the coils are placed in open slots, and thus easily removed and replaced in case of break downs. The ends of the coils, where they project beyond the core, are well protected by the stator yoke and end housing.

One of the features which makes the squirrel-cage motor best adapted for operating centrifugal pumps is the fact that the rotor is made extremely rigid, and is thus able to withstand the high speed at which centrifugal pumps are operated. In this case the rotor punchings are mounted on a cast-iron spider, having arms shaped to act as fans and thus force air through the rotor. What may be considered the winding of the squirrel-cage rotor consists of single copper bars placed in nearly closed slots around the periphery of the rotor, and bolted to short circuiting rings at each end.

Potential starters are used in starting this type of motor, which reduce the pressure applied to the stator windings during the starting period. The starter consists of auto-transformers for lowering the voltage, and an oil-immersed controller for making the necessary changes when passing from the starting to the running position. They are provided with a number of taps so

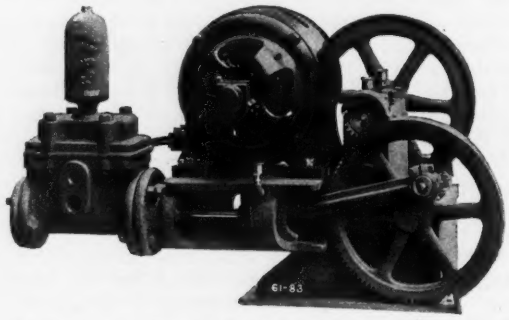


FIG. 2. WAGNER SINGLE-PHASE MOTOR DRIVING A POWER PUMP

that the pressure applied at starting can be adjusted to suit the load conditions under which the motor operates. In the smaller sizes for low voltage motors, the auto transformers are mounted together with the controller, while in the large starters the controller and auto transformers are mounted separately. All starters are arranged so that it is impossible to throw them from the off to the running position without first passing through the starting position.

Either 2 or 3-phase motors can be used for this purpose and after they are once started they are frequently kept in continuous operation, the only attention necessary being to watch the condition of the bearings.

The operation of power pumps is somewhat different from that of centrifugal pumps, in that the speed of the motor employed is usually lower, and the load is apt to be varying. In Fig. 2 is shown a pumping unit consisting of a single-phase, constant-speed motor made by the Wagner Electric Mfg. Co., geared to a reciprocating pump. This motor is operated by line current passing into the field winding only, all armature currents being developed by induction. This construction permits of a thorough insulation of the entire motor, and thus practically eliminates all grounding difficulties.

Another feature is that a commutator placed on the armature is employed for deriving starting torque, the brushes on the commutator being closed on themselves. This is what is known as the repulsion method, and is used to develop a high starting torque. On attaining full speed the individual segments on the commutator are completely short circuited and simultaneously the carbon brushes are removed from the surface of the commutator.

A third characteristic is that upon attaining full speed there is created in the armature windings, by virtue of the closing of the individual coils upon themselves, a multiplicity of alternating currents, the reactive effects of these currents on the field winding being such as to establish a rotary field.

Under ordinary conditions where normal starting

torque is required, the attendant simply closes the main line switch, and the motor takes care of itself. The automatic feature is a centrifugal governor device contained inside the armature. At the proper speed this comes into action, throwing into the commutator a short circuiting link, which transforms the motor from the repulsion to the induction type.

The simple starting operation of this form of motor adapts it well to the automatic charging of water or air tanks, as the motor may be started or stopped by a float or pressure switch.

TABLE 1. MOTORS FOR MACHINE TOOLS

Tool	Direct current			Alternating current		
	Shunt	Comp.	Series	×	♯	*
Bolt cutter	†			×		
Bolt and rivet header		20% 40%		×	♯	
Bulldozers		20% 40%		×	♯	
Boring machines	†			×		
Boring mills	†			×		
Raising and lowering cross rails on boring mills and planers		60%	†		♯	
Boring bars	†			×		
Bending machines		20% 40%		×	♯	
Bending rolls		40% 80%	†			*
Corrugating rolls		20% 40%		×	♯	
Centering machines	†			×		
Chucking machines	†			×		
Boring, milling and drilling machines	†			×		
Drill, radial	†			×		
Drill press	†			×		
Grinder—tool, etc.	†			×		
Grinder—castings		20%		×		
Gear cutters	†	20%		×		
Hammers—drop		20% 30%			♯	
Keyseater—milling—broach	†			×		
Keyseater—reciprocating	†	20%		×		
Lathes	†			×		*†
Lathe carriages			†		♯	
Milling machines	†			×		
Heavy slab milling	†	20%		×		
Pipe cutters	†			×		
Punch presses		20% 40%		×	♯	
Planers		20%		×	♯	
Planers—rotary	†	20%		×		
Saw—small circular	†			×		
Saw—cold bar and I beam	†	20%		×		
Saw—hot		20%		×		
Screw machine	†			×		
Shapers	†	20%		×		
Shears		20% 40%		×	♯	
Slotters	†	20%		×		
Swaging		20%		×	♯	
Tappers	†			×		
Tumbling barrels or mills		20%		×		

× Squirrel cage rotor.
♯ Squirrel cage rotor-high starting torque.
* Slip ring induction motor with external rotor resistance.
† Might be used for tire lathes as it allows slowing down when cutting hard spots.

Motors in Machine Shops

IN machine hops where motors can be applied for individual or group driving, this form of power is almost without competition. And while volumes have been written upon this one subject alone, it is not the intention to go into details here, but merely to give the reader an idea as to the proper type of motor to secure for driving certain of the most important machines.

In this connection we give the Table I, which was presented by Charles Fair in a paper at a meeting of the American Society of Mechanical Engineers. It is a guide to engineers using motors for driving machine tools. In this table it has been necessary to double check a number of the tools owing to the great variety and the sizes of tools of the same name when put in a general list. It must be kept in mind, however, that various circumstances such as size or roughness of work, flywheel capacity, and so forth, may call for radical departures in choice of motors, this list being compiled to meet average conditions only.

In this class of work the choice of motors should go hand in hand with that of the control. It is necessary in this connection to consider the nature of the work, its accessibility to the operator, the method of attaching it to the tool, and in some cases its relative position to other tools; for instance, an open type starting rheostat

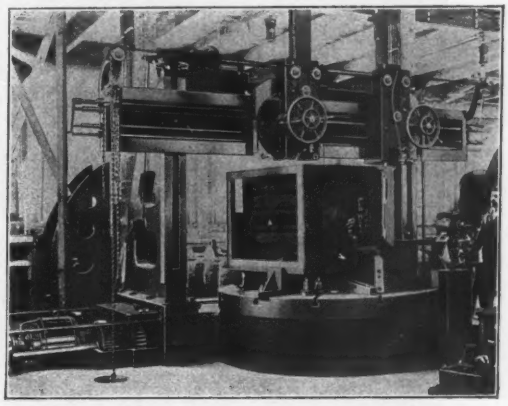


FIG. 3. BULLOCK TYPE K MOTOR DRIVING A BORING MILL

should not be exposed to danger of short circuit from flying chips. In the majority of cases a shunt motor of ¾ hp. and less should be started by a switch. Exceptions to this would be motors on tools that must be gotten under way slowly, and grinders driven by direct-current motors for reasons of safety. With adjustable-speed motors care should be taken to throw the switch on full field.

Series motors up to 8 hp. or even larger can be started by a switch. Exceptions to this would be cranes and tools requiring a certain amount of armature speed regulation. Larger motors for tools where starting service is infrequent or not severe, for line shafts and for group drives, would be satisfactorily operated with a dial type controller, which is cheaper than the drum controller, provided, however, that the controller is placed in a protected position.

In Fig. 3 is shown a Bullock motor, type K, driving a boring mill at Fore River Ship Yards. This motor is compound wound, and is thus able to take care of the variation in load which is placed upon it. The magnetic yoke is made of cast iron. In the smaller sizes the yoke and base are cast in one piece, while in the larger sizes the yoke is cast separate and bolted to the base. The inside of the yoke is bored concentric with the shaft, and to this finished surface the poles are bolted by cap screws, whose heads are countersunk below the external surface of the yoke.

The series and the shunt coils are insulated sepa-

rately, and are placed side by side on the poles with the series coils nearer the armature.

Armature coils are held in the slots by hard wood wedges fitted into grooves at the top of the slots. A steel wire band at the back end binds the armature coils down tightly against the cast-iron end head, and a similar steel wire band binds the coils at the front end between the armature core and the commutator. The armature coils are made of strip copper bent into shape so as to be interchangeable on the same armature.

Motors used for driving individual metal working tools are frequently so placed that they are surrounded by chips of iron which are attracted by the field poles, and it is necessary in such circumstances to protect the armature from injury by enclosing it entirely with iron plate. Motors so enclosed become hot when ventilation is not provided, and must be built on more generous proportions than the open type.

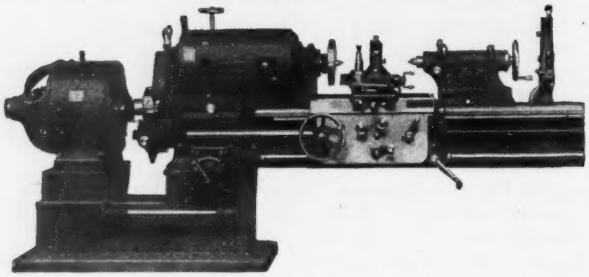


FIG. 4. RELIANCE ADJUSTABLE-SPEED MOTOR DRIVING A 20-IN. LATHE

Many of the tools used in a machine shop require a variable speed, and the demand for motors which can be connected to such tools without the necessity of intervening gearing has led a number of the manufacturers to develop special, variable-speed motors, with speed ranges to suit the demands of the tools upon which they are used. In Fig. 4 is shown the Reliance Adjustable Speed motor, driving a 20-in. lathe, which is made with speed ranges from 2 to 1 to 10 to 1 or greater, if required, and may be wound for 110, 220 and 500 volts direct current. It is a 4-pole, shunt-wound machine, and means are provided for moving the armature in or out between the field pole pieces; as the armature is withdrawn the magnetic resistance increases and the magnetic flux decreases, the result being increased speed.

FIG. 5. MACHINE SHOP DRIVEN BY MECHANICAL APPLIANCE CO. MOTORS.

In order that the air gap may be increased more quickly, the armature is slightly larger at one end than at the other. This with the decrease is magnetic area gives a greater variation in speed than would otherwise be possible. The commutator end is supported by a thrust bearing which is made solid and capable of being moved in or out by turning a hand wheel.

Ample provision is made to guard against sparking, particularly when the armature is drawn out, in which case it comes into a commutating field especially provided for the purpose, the result being sparkless commutation at all speeds and loads.

Suitable means are provided to counterbalance the magnetic pull on the armature, greatly facilitating the ease with which speed adjustments are made. An additional feature of the thrust bearing is a scale on which the approximate speed of the motor is indicated. The torque of the motor varies inversely with the speed, thereby maintaining a constant horsepower output.

The facility with which the direct-current electric motor lends itself to speed control has been one of the most important factors in its increased use. Much as the group drive had to recommend it in point of economical operation, it was soon found that not only was it possible to increase this feature by further subdivision, but it was also possible by so doing to secure a fuller advantage of the possibilities of speed variation which to a large extent was sacrificed in the group drive.

There has been an increasing activity in the direction of individual motor drive and in Fig. 5 is illustrated a modern machine shop equipped with Watson individual motor drive.

Provision has been made in the design of frames of these motors for unusual flexibility so that they

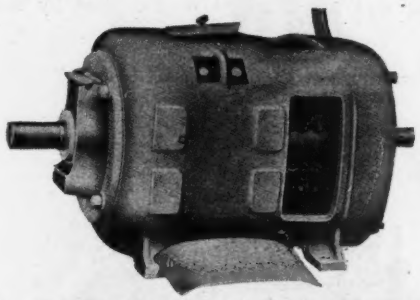


FIG. 6. WESTERN ELECTRIC TYPE H HOISTING MOTOR

may readily be adapted to meet special conditions where a standard motor cannot be used to advantage. The motors used in the shop illustrated are principally of the shunt-wound type and provided with

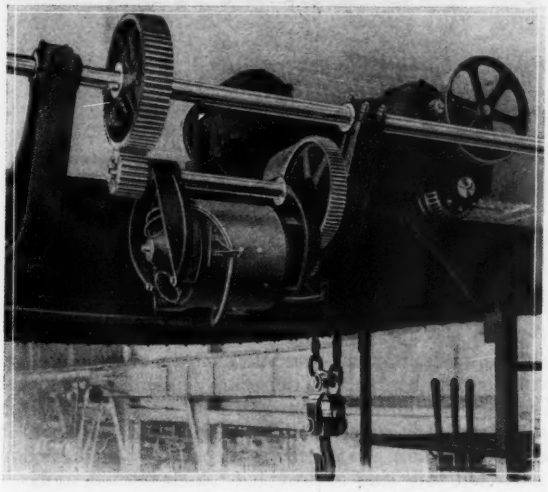


FIG. 7. ELECTRIC CRANE DRIVEN BY WESTINGHOUSE SERIES MOTORS

field controlling rheostats, giving each operator means by which he can control the speed of his machine to a very fine point.

Hoisting Motors

SOME of the characteristics which are required of motors for hoisting purposes are that they should be compact, with marked series characteristics, and adaptable to intermittent service. These characteristics are well exemplified in the type H hoisting motor, made by the Western Electric Co. shown in Fig. 6. To render the motor as compact as possible, without detracting from the output, the diameter of the armature has been reduced, which is compensated for by extra length. Not infrequently a type of brake is used in hoisting work capable of stopping the motor almost instantly, thus producing a heavy strain on the motor shaft. To insure against trouble from such strains an exceptionally large shaft is used.

The pole pieces, field coils, and the general detail construction of the magnetic circuit have been designed for this particular kind of work. The field is so proportioned as to operate at normal load with a low magnetic field density with the ability to stand enormous over loads and heavy starting torques. In motors for hoisting service quite different conditions exist as such service is essentially intermittent, and therefore, does not permit of any tabulated rating.

Electrically Driven Cranes

FOR driving electric cranes, enclosed series wound, direct-current motors are usually employed as is indicated by the accompanying illustration, Fig. 7, of an electric crane, equipped with 3 type L Westinghouse mo-

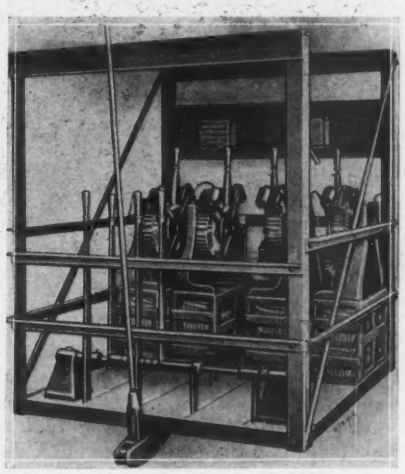


FIG. 8. WESTINGHOUSE CRANE CONTROLLING APPARATUS

tors. Since the torque of a motor is approximately proportional to the product of the armature current by the field strength, the torque of a series motor, up to the point of saturation of the magnetic circuit increases as the square of the current. Such a motor is therefore well adapted for starting and accelerating heavy loads. The speed of the motor which is controlled by varying the electromotive force applied at the armature terminals is changed by inserting resistance in the circuit, and the control is accomplished through a controller, which is immediately under the hand of the operator.

The general characteristics of these motors are that the field frame is made in one cylindrical piece, which is closed by 2 end brackets bolted tightly to the frame. The end brackets carry self-oiling and self-aligning bearings. There are large openings in the front end brackets over the commutator which gives easy and convenient access to the interior of the motor, and the rear bracket has a similar opening; these openings are covered by tightly fitting spring lids hinged to the brackets. In other respects the motor has the characteristics of any series motor with the exception that the armature is slightly less in diameter compared with its length than is the usual custom.

Controlling apparatus of motors subjected to frequent stops and reversals, such as shown in Fig. 8, must be of the strongest kind. Such controllers must give per-

fect control of speed and directions of rotation, be convenient to operate, and of such simplicity in design as to allow necessary repairs to be made even by an unskilled attendant.

The contact pieces for these controllers are made of hard drawn copper and are easily renewed without disturbing the connections to the resistances. The contact fingers are of cast brass provided with removable drop-forged copper tips held in place by 2 screws. A heavy shunt made of copper strips connects the finger to its supporting frame, thus insuring good electrical connection betwen the finger and frame, preventing the burning of the former at the hinged joint. Destructive arcing is eliminated by the provision of effective blow-out coils, and the opening of the circuit at 4 different points. The resistances used with these controllers, consist of a combination of units connected in series or multiple according

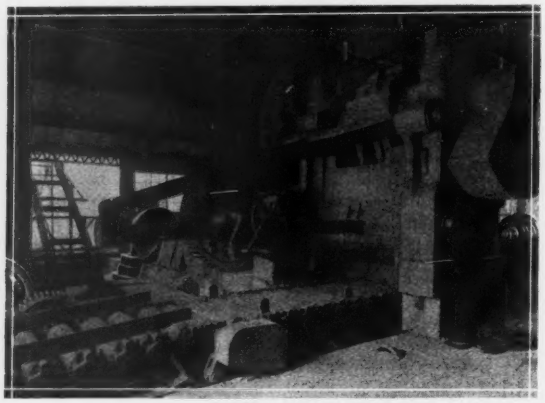


FIG. 9. CROCKER-WHEELER MOTORS DRIVING A BLOOM SHEAR

to the capacity required. These units are so arranged as to be easily renewed or repaired if this be necessary. The resistances are made practically indestructible by the use of non-combustible material throughout.

Rolling Mill Motors

PERHAPS the most severe service to which electric motors have been subjected is that of running big rolls, shears, lathes, etc., in steel mills and large machine shops. Up to a comparatively short time ago individual steam engines or rope drives from the main or counter shaft were used for doing this work, but in recent years the electric motor has been developed to such an extent that its use is becoming almost universal. It is simple and easy to operate, has great momentary overload capacity, is highly efficient and there is little wear and tear.

Owing to the large size of motor required the speed is naturally low, which makes direct connection possible and saves the power otherwise lost in transmission machinery. By subdividing the units, and using a separate motor for each moving part of the machine, entirely independent control of the various parts is simply obtained. As an example of one of these installations we illustrate in Fig. 9 a bloom shear driven by large Crocker-Wheeler motors. In this instance compound, direct-current motors are employed.

The magnetic frame of these motors is of cast iron with internally projecting flanges to insure ample stiffness. The frame is split horizontally, the 2 halves being accurately lined by dowel pins and held together by bolts. The poles are of cast steel, welded into the frame in such a manner as to insure a perfect magnetic joint.

Each pole is fitted with a cast-iron removable shoe, which is designed to produce the best distribution of magnetic flux over the armature and which serves to retain the field coils in position. The air gap is relatively large, which is a valuable feature as it tends to reduce any bad effects resulting from slight displacement of the armature from its true center which occasionally happens in heavy work of this class.

There are at least 2 sections of coils per pole, and in large sizes there is a still further subdivision of the coils. The various sections are separated from each other and the frame by spaces, so as to provide free circulation of air between and around the coils, which insures uniformly low temperature throughout each coil, and permits heavy and continued overload without excessive heating in any part.

The armature conductors consist of flat or round copper wire without joints of any kind. They are heavily insulated, and are retained in the slots by means of

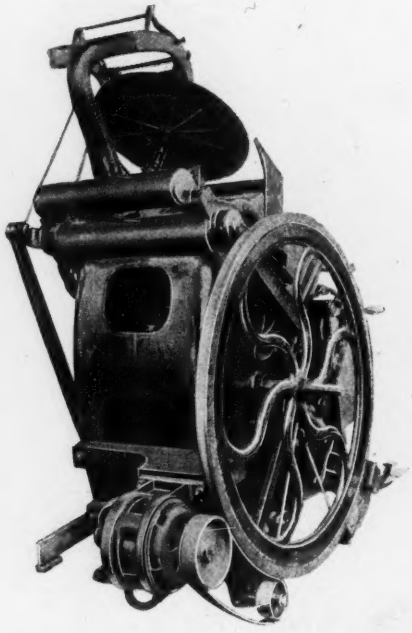


FIG. 10. GORDON JOBBER OPERATED BY A GENERAL ELECTRIC SINGLE-PHASE MOTOR

wedges, except in the small machines where band wires are used for this purpose.

The commutator is mounted on an extension of the armature spider, and is thus independent of the shaft. The bars are made of hard drawn copper, extra deep, and designed to give a maximum wearing depth and liberal commutator surface. In the large sizes a sectional front clamping ring is provided which permits removing a few bars without disturbing the others.

All motors for driving machinery in steel rolling mills are of the heaviest mechanical and electrical construction as the demands are extremely severe, and reliability of service absolutely essential.

The Motor as an Aid to Printing

ONE of the broadest fields which is open to the electric motor today is in printing establishments. While the power used here is not extensive, it is one of the most exacting to which a motor can be applied. Motors that are used for driving small job presses, for instance, are put under trying conditions in that they are usually stopped and started frequently, and while running are subjected to a variable load. It is also desirable to run

these presses at different speeds according to the class of work being printed upon them.

Up to the time when small single-phase motors were put upon the market, printing establishments were limited to direct current for their electric power, and while direct-current motors for this purpose are usually highly satisfactory, in many small cities nothing but single-phase current is available, and the perfection of the single-phase motor of small capacity has greatly broadened the field in this direction.

Figure 10 shows a General Electric ½-hp. motor operating a Gordon jobber. This type of motor is adaptable

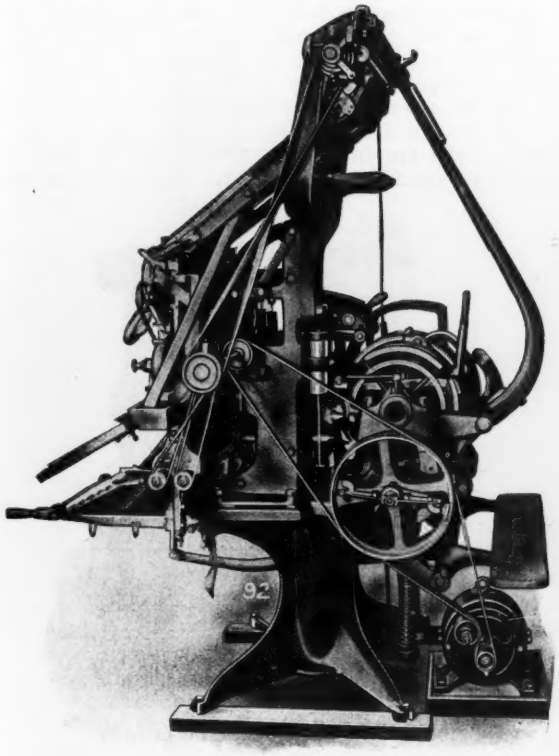


FIG. 11. THE STANDARD LINOTYPE MOTOR ATTACHED TO MACHINE

to the operation by belts, gears or clutch couplings, of machines requiring constant or variable speed and moderate or heavy starting torque. The field of the motor has a single-phase winding of the concentric type, each coil being attached and insulated separately.

Armature winding is of the series drum type, connected to a commutator carrying 2 sets of brushes, each set being displaced electrically from the other by 90 deg. The first set, known as the energy brushes, is permanently short circuited and disposed at an angle to the lines of field or primary magnetism as in an ordinary repulsion motor. The second set, or compensating brushes, is connected to a small portion of the primary winding included in the field circuit, so as to impress upon the armature an electromotive force which serves both to raise the power factor, and at the same time to maintain approximately synchronous speed at all loads.

One of the features of this motor is that it will start itself by throwing it directly across the line, in which case it will develop some 300 to 400 per cent full-load torque with from 300 to 400 per cent full-load current. If sizes above 2 hp. are installed on the same line with arc or incandescent lamps, or where otherwise essential to minimize the initial current at starting, it is advisable to use a rheostat. In this case approximately 2.25 times full-load current will be required to secure full-load torque.

Where a controller is used this type of motor is capable of giving a speed variation of 50 per cent below synchronous speed by inserting resistance or reaction in the energy and compensating circuits. By the addition of a special winding having terminals for connection to a 4-pole double-throw switch this type of motor is capable of being reversed.

A small direct-current motor has been developed by the Robbins and Myer Co., especially for operating linotype machines. The illustration, Fig. 11, shows the motor as it is usually attached to the machine. Being underneath the step it is out of the way, yet easily accessible, and offers a simple, satisfactory and inexpensive power for driving these machines. The motor is shunt wound in order to give constant speed and has a capacity of ¼

FIG. 12. GENERAL ELECTRIC MOTORS IN A CEMENT PLANT

hp. running at 450 r.p.m. It can be furnished for any voltage desired and is supplied with a pulley which belted directly to the 14 in. pulley of the linotype machine gives the correct speed as generally required.

A starting box or speed regulator is not usually required with this equipment, the motor being started and stopped with a knife or snap switch, located within easy reach of the operator.

Electric Drives in Cement Plants

THE general advantages which apply to individual drive of machines are equally applicable to the manufacture of Portland cement, but there are certain inherent requirements in this industry which favor the use of electric motors for this class of work. The machinery is worked continuously, night and day, and a shut down of any one machine or the failure of its driving power, must not affect the operation of any other machine. Most of the machines used in the manufacture of cement start under a heavy overload and some are liable to short overloads during operation. The driving unit must be designed to give the best efficiency at the load required in normal operation, and yet have a large margin of overload capacity which can be drawn upon at starting or when necessary.

The motors which are installed in cement plants should be of a rugged type, such as to need little attention, and to operate in an atmosphere thick with stone and cement dust. Under these conditions the induction motors seem to give best service as there are no moving contacts and no parts to get out of order except the bearings, which are always well closed and housed.

In Fig. 12 are shown a number of General Electric Form K motors, driving Kent mills in the Sandusky Portland Cement Co.'s works at Dixon, Ill. This type of motor is especially adapted to work in cement mills,

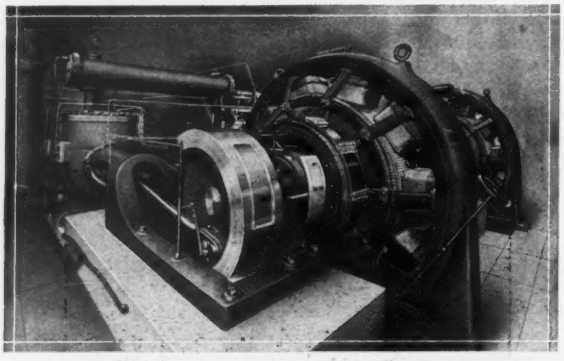


FIG. 13. AIR COMPRESSOR WITH MOTOR DRIVE

and is given the normal running horsepower rating of the machine it drives. These motors are supplied with high resistance rotors, for producing a starting torque of twice normal value, if necessary. The rotor bars of motors intended for use in connection with grinding,

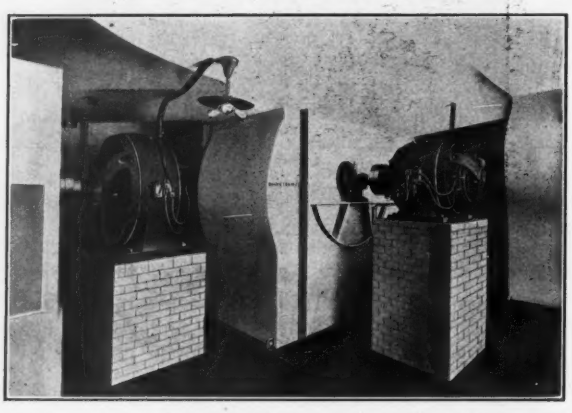


FIG. 14. VENTILATING FANS DRIVEN BY SPRAGUE ELECTRIC CO. MOTORS

crushing and burning machinery are bolted to the end rings instead of being soldered, which enables the motor to stand the heavy current required for starting. For starting the motors compensators are used which are arranged with a latch so that the operator cannot throw the motors directly on the line.

Motor Driven Air Compressors

INCREASED use of compressed air for operating small tools in electrically driven machine shops has made necessary the application of motors for driving air compressors. In Fig. 13 are illustrated 2 air compressor units which are driven by 480-hp. type MPL Wood motors. Aside from the economy of this type of drive there is also an ease of operation which is especially commendable for the direct-connected unit, as each compressor is easily and automatically controlled. This line of direct-current motors has been particularly designed to meet the demands of power users for motor drive of individual large machines. The motors are adapted for use wherever special requirements are essential factors in satisfactory operation.

Field frames are cast in 2 pieces so that they can be separated on a vertical line, thus enabling them to be removed without interfering with the bearings or alinement of the compressor.

Fans and Ventilators

FOR handling large quantities of air where fans or blowers are used in ventilating public buildings, hotels and the like, direct-current motors are adopted with good results as their efficiency is high and the control apparatus simple and easily operated. In the illustration, Fig. 14, are shown 2 Sprague Electric motors driving fans in the sub-basement of the Hotel Knickerbocker. These are direct connected to the fans, and arranged for control from a distance. In this case, as the

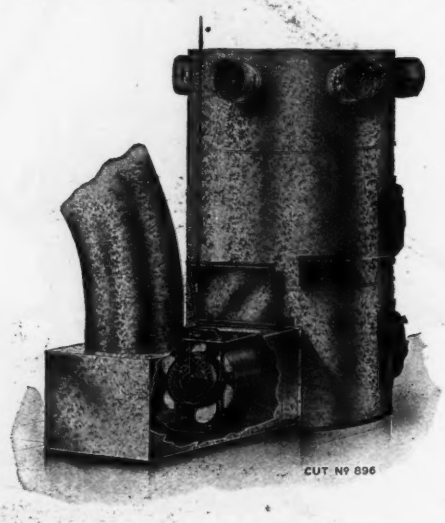


FIG. 15. ELECTRIC FURNACE BLOWER

load does not vary, shunt-wound motors are employed, which give the fans a constant speed.

The electric furnace blower is a valuable auxiliary to the hot-air furnace commonly used in residence heating. In almost every house there are certain rooms which cannot be kept comfortably warm without some means for forcing the hot air into these rooms. The blower outfit which is illustrated in Fig. 15 is the product of the Emerson Electric Mfg. Co., and designed especially for residence work.

The outfit consists of a special motor equipped with a 6-blade quiet fan and mounted substantially in a sheet-iron casing with cover and handles. It is placed in the cold-air box of the furnace, and controlled from any point desired about the house. These blowers are equipped with either direct or alternating-current motors. When the alternating-current motor is used, it is of the induction type without brushes or commutators, and is equipped with an automatic starting device to insure a prompt start when the current is turned on. Direct-current motors necessarily have brushes and a commutator. Since the radiating tubes of a hot-air furnace would convey any noise readily it is necessary that a motor used in this connection with a furnace should be noiseless in operation.

The Sturtevant electric propeller fan consists of a propelling wheel and motor on the same shaft. The

wheel has galvanized steel blades of special design to handle the air without permitting reverse currents, and revolves in a cast-iron wall ring. Fig. 16 shows the general construction of an outfit for mounting in the side wall of a building, which is the usual custom for ventilating.

The motor for driving the fan is of the enclosed dust proof type, made of large proportions to offset the lack of ventilation caused by enclosing the motor. Automatic lubrication permits operation for several weeks without attention.

To handle air most economically under the varying conditions usually found in practice this device is

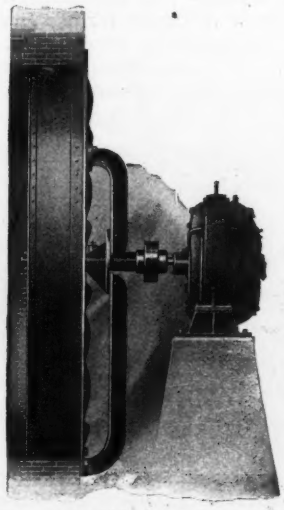


FIG. 16. THE STURTEVANT ELECTRIC PROPELLER

equipped with a regulating rheostat of capacity sufficient to reduce the speed of the fan to 50 per cent of the maximum. It provides for 10 to 12 different speeds and is equipped with an automatic device which opens the circuit when the supply of current is interrupted, thereby preventing possible damage when the current is suddenly turned off. Owing to the demand for varying speed, and as the load is a constant one the motor used is shunt wound for direct current.

The electric propellor fan of standard construction is usually placed with the shaft horizontal but can readily be arranged in a vertical position in which case the lower bearing is provided with a ball and oiled by a grease cup.

Ill effects resulting from remaining in a constant current of air have been eliminated by various types of fans equipped with special attachments for controlling the direction of the current of air. One method is that employed by the Fort Wayne Electric Works and accomplishes the desired results by an arrangement which keeps the fan continually rotating about a vertical axis. The case of the motor is small and of light weight, being 3⅝ in. in diameter and cast of aluminum.

The motor revolves on a ball bearing within an enclosed case, which also contains sliding contracts by means of which the current is conveyed to the motor terminals. The shaft of the motor is mounted in place at an angle of 45 deg. to the vertical axis of the complete structure, the result being that the top fan blades are farther from the center of rotation than the lower blades, thus producing an unbalanced condition which causes the motor to revolve in a horizontal plane, distributing at intervals the air to all parts of the room.

In Fig. 17 is illustrated the field and armature of a single-phase motor employed for driving this fan. The machine is of the induction type and is provided with a 4-pole field magnet. The armature is of the squirrel-cage construction with laminated core, the conductors consisting of uninsulated copper rods which are placed in slots crossing the core diagonally. This construction reduces the humming noise which is frequently made by induction motors.

Motor Operated Tools

MOTORS used for driving machine tools and other small types of machinery are frequently required to run on variable-speeds, and this demand has caused the development of a number of types of variable-speed motors; one arrangement being to vary the air gap of the magnetic circuit by changing the position of the field pole. The sectional view of the Stow bi-polar multi-speed motor which is shown in Fig. 18 conveys

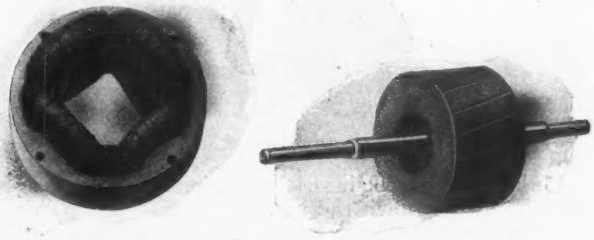


FIG. 17. FIELD AND ARMATURE OF WOOD FAN MOTOR

a clear idea of the inner construction of a motor designed for controlling speed by varying the length of air gap. Like the ordinary shunt motor with field regulating rheostat, these motors owe their speed regulation to the variation of field strength, but unlike the common shunt motor the flux at the pole tips utilized in commutation is, by a special construction of

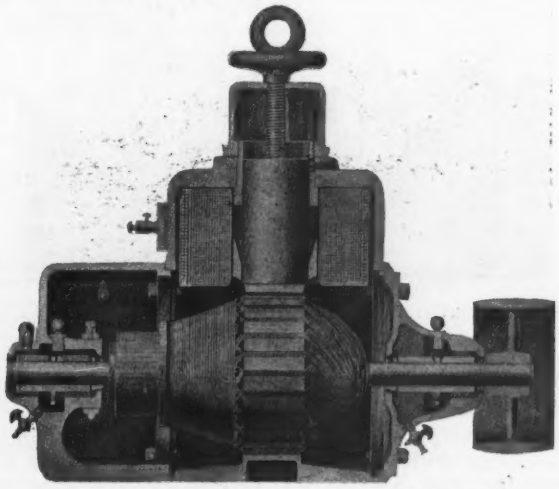


FIG. 18. BI-POLAR STOW MULTI-SPEED MOTOR

the pole pieces, maintained practically constant, irrespective of the changes of total flux acting on the armature.

The pole piece comprises a pole shoe of common form, rigidly connected to a cylindrical shell over which the magnetizing coil is wound and within which is a solid core of high permeability and of a cross section relatively large as compared with the conducting area of the enclosing shell. By means of a hand wheel this inner core or plunger is adjusted in a direction

radial to the center of the armature and is so proportioned that a slight variation in its position within the magnetized shell produces considerable difference in the reluctance of the magnetic circuit of which the plunger forms a part.

Since the magnetomotive force of the field coil remains constant, the volume of magnetic flux becomes a maximum when the plunger is at its innermost position, at which time the speed is at its minimum or normal. As the plunger is being drawn away from contact with the pole shoe the reluctance of the magnetic circuit becomes greater, and when the extreme outermost limit of the plunger is reached, the speed becomes maximum.

With this type of motor an operative range of speed of 140 per cent for a ½ hp., up to 300 per cent for

FIG. 19. MOTOR OPERATED HAND DRILL

a 15 hp. can be obtained, the minimum speed being the normal for which the machine is designed. This variable speed control, together with a universal joint makes this motor applicable for driving almost any small tool which is used about factories or machine

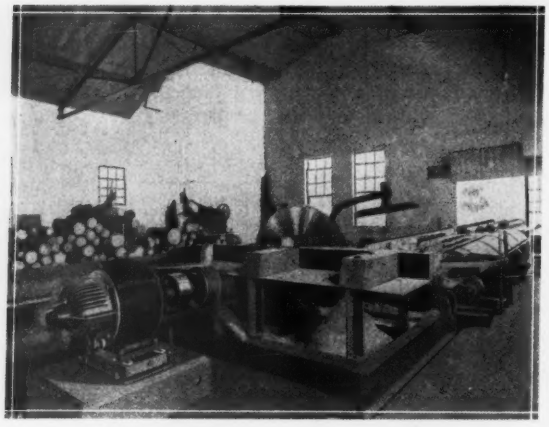


FIG. 20. NORTHERN ELECTRIC CO. MOTOR DRIVING A 48-IN. WOOD SAW

shops such as portable screw-feed drill presses, grinders, augers, tapping and reaming machines, etc.

Demand for motors to drive hand tools and other small implements has been recognized by a number of manufacturing concerns and several sucessful lines of motors for both alternating and direct-current circuits have been developed. The motors of this type built by the Fort Wayne Electric Works range in size from 1/100 up to 1/15 hp. capacity.

Figure 19 shows an application of a type GD motor operating a hand drill. This motor is for direct current only. Motors of this type are made in 2 sizes, 3⅝ and 5¼-in. frames. These are wound for speeds and output ranging up to 1-30 hp. at 1800 r. p. m. or 1/15 hp. at 3000 r. p. m. The speeds mentioned here are for full load.

Shunt motors of large capacities have a fairly constant speed, but of low capacities there is a variation of 15 to 25 per cent from no-load to full-load speeds, and for that reason the 3⅝-in. frame motors are not made shunt wound. The 5¼-in. frame motors are shunt wound for 110 volts or less. Both frames are standard for series winding and here the speed varies with the load so that the ratings refer to exact full load. If the motor runs under light load the speed is apt to be excessive, while if overloaded the speed falls below normal.

The same general conditions as to rated speeds exist in the small alternating-current motor as in the direct-current motor. The alternating-current motors are designed in 3 different forms, enabling them to meet all the demands for application of motors for small outputs. The alternating-current motors can be supplied either as series-wound or repulsion motors, either of which has speed characteristics similar

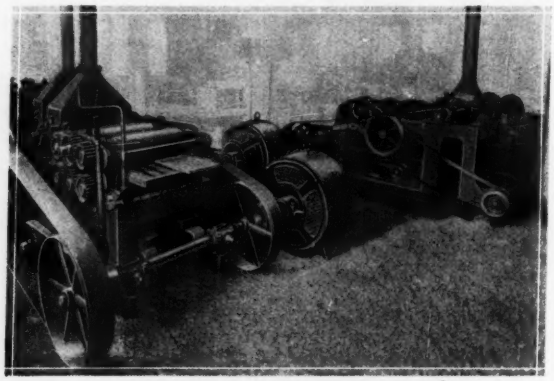


FIG. 21. WOOD PLANING MACHINERY EQUIPPED WITH WESTINGHOUSE MOTOR

to the series direct-current motor, the speed varying rapidly with the change of load.

Pulp and Paper Mills

ELECTRICAL operation of machinery used in pulp and paper mills has become quite common in recent years, and presents many advantages which cannot be obtained where purely mechanical means are employed. Like the power used in machine shops, that used in mills for the manufacture of pulp and paper meets almost all conditions of varying load, constant speed, and speed which must be hand regulated.

There are other conditions peculiar to the industry such as acid fumes, moisture, dust, etc., which make the selection of the type of motor employed quite a problem. The induction motor lends itself readily to the pulp mill where moisture and acid fumes are prevalent, as the current carrying parts can be thoroughly protected from the effects of moisture and sulphur fumes and in some mills it is used throughout with the exception of instances where regulation of the speed is necessary.

Where a varying load is encountered and a constant speed desirable, the direct-current compound-wound motor is usually employed.

Figure 20 shows the method employed in the Consolidated Water Power & Paper Co.'s plant for driving a 48-in. wood saw by a Northern Electric Co.'s enclosed spherical compound-wound motor. In this case the load comes on suddenly and as no flywheel is employed the motor must maintain the driving speed of the saw and for this reason a compound direct-current machine is most suitable.

For protecting the commutator and brush holder

from flying chips and pieces of wood, which are likely to be thrown around the room, a guard is placed over this part of the motor as is indicated in the illustration.

Wood Working Machinery

IN furniture factories, planing mills, saw mills and other industries where wood is worked up into various shapes by machinery the electric motor has a field almost without competition. The loads encountered here are also of varied classes and the selection of motors best adapted for the work is one requiring considerable experience and judgment on the part of the engineer.

In Fig. 21 is shown the application of Westinghouse type S motors in a wood working mill. In this particular instance the load is variable, consequently direct-current compound-wound motors are employed. These motors are enclosed with shields which protect them from chips and flying materials, yet they have sufficient ventilating space provided to take care of the heat of the motor.

In many of the wood working factories where buffers and other machinery fill the air with fine sawdust, the advisability of using induction motors can hardly be questioned as the danger of fire from sparking commutators and moving electrical contacts is entirely eliminated.

Motor for Pipe Organ

ONE of the most trying conditions under which a motor can operate is that of working the bellows for a church organ. The low and disagreeable noise which is frequently made by alternating-current motors has always been a drawback to their being used for this purpose. If installed near the organ the hum set up disturbs the music. The load placed upon the motor used for this purpose is one that is extremely variable and full loads as well as minimum loads must be met instantaneously.

Figure 22 shows an installation of a Kimble variable-speed motor operating the bellows of a church organ. The motor is of the single-phase alternating current type and so constructed that it is perfectly silent in operation. These motors have a long lever for shifting the brushes bent over to extend in a position horizontal to the motor, and by means of a chain and weights the bellows are kept inflated automatically.

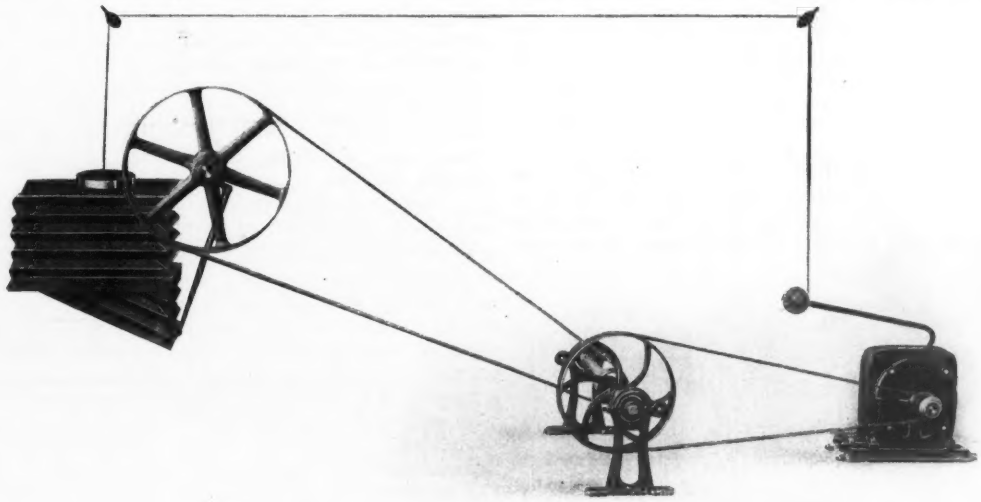


FIG. 22. ORGAN BELLOWS OPERATED BY KIMBLE VARIABLE SPEED MOTOR

COMPARISON OF OPERATING COSTS

THE following comparison between 2 great apartment houses in New York City may be of interest from the standpoint of operating cost of power plants, especially as one of the houses contains an isolated plant, and burns low grade fuel exclusively, while the other buys electricity from a central station and burns No. 1 buckwheat at $3.35 a ton. Both are heated on the single-pipe system, have electric elevators, and the tenants pay for their own light. The Hendrik Hudson is an 8-story building, while the Cromwell consists of 5 6-story buildings, part 100 by 100 and part 125 by 100, occupying the north side of 137th St. from Broadway to Riverside Drive.

The Cromwell with 2.5 times the apartments, 25 per cent greater cubic contents, and 30 per cent more floor space, costs $800 less to operate than the other. By ordinary methods it would cost $5000 more to operate, excluding fixed charges on the power plant.

COST OF OPERATING THE HENDRIK HUDSON AND THE CROMWELL BUILDINGS COMPARED

	Hendrik Hudson	Cromwell.
Approximate area of a typical floor sq. ft.	22,000	32,000
Total floor area, including basement sq. ft.	171,200	221,900
Number of elevators	2	6
Number of boilers	3	3
Annual cost of coal	*$4,381	**$6,043
Public electricity (assuming 5c. per Kw. hr.)	$2,552	$3,892
Cost of tenant's electricity	$3,500	$5,253
Approximate cubic contents	2,000,000	2,000,000
Number of apartments	72	175
Total number of Kw. hrs.	85,000	138,000
Number of sq. ft. heating surface	14,350	22,000
Net cost of operation, deducting receipts from tenants	$10,437	$9,602

*Heat only. **Heat, light and power.

It would be borne in mind, too, that the Cromwell has 6 elevators against the other's 2, that the buildings are extended over a far greater area, so that the cost is proportionately increased, i. e., the steam, has to be conveyed 600 ft., maximum from the boiler, as compared with 300 or 400 ft. The greatly increased number of families also increases the amount of hot water used, and, therefore, the amount of fuel to heat such water.—The Isolated Plant.

Letters From Engineers

Tell us about your new kinks and new thinks. Rough sketches are always helpful; we make the drawings. Cash paid for accepted contributions.

. FEED-WATER HEATER FROM A BOILER .

IT is an old saying that success attends those who make the best use of what they have, and in proof I will describe how one man made good use of a condemned boiler and has saved his employers more than the price of 2 new boilers since his plan was put into effect.

This firm didn't believe in investing good money in what they termed foolish equipment (you all know the breed). But their engineer knew that a feed-water heater would save the cost of itself many times over,

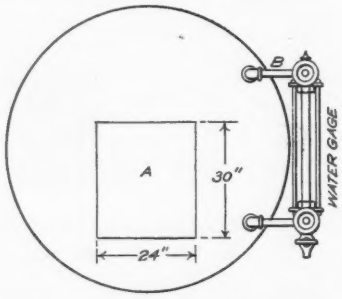


FIG. 1. END VIEW OF HEATER SHOWING DOOR AND WATER GAGE

therefore as it was a plain case of the employers hailing from Missouri, the engineer proceeded to show them.

Now, it happened that this firm had had one of its tubular boilers condemned on account of age, and as it had lain in the mill yard for some time with no prospect of a buyer, the engineer obtained permission to make what use of it he could to benefit his employers and get it out of the way.

He removed all the tubes and plugged the holes in the tube sheets. In one end he cut a square space and fitted a door as shown in Fig. 1. He now had a hollow cylinder 6 ft. by 17 ft. 6 in., and this he located near the boilers at a point several feet lower than the mill and piped all the returns from the heating and drying system in at A Fig. 2, with a 4-in. pipe. Directly opposite at B he tapped in another 4-in. pipe through which he supplied his heater with water from the hotwell from an 800-hp. and a 400-hp. Corliss engine with Bulkley condenser.

This water was spread by means of a baffle plate C and at D he placed an overflow pipe 6 in. in diameter; near the center he set a short pipe E connected with the suction pipe to the boiler feed pumps, 6 in. diam. He next combined the exhaust pipe from 3 small machine engines and tapped the top of the heater with an 8-in. pipe let in 6 in. below the water line, as shown at F.

His heater was ready for a trial which was made, but as it gave trouble on account of too much pressure forcing the water out through the overflow, he fitted a 3-in. low-pressure relief valve, as shown at G. That helped the matter, but at times he could not get the required amount of water and furthermore he was annoyed by the constant blowing of steam from both the relief valve and overflow. To remedy this he fitted a 2-in. shower pipe as shown at H, drilling ¼-in. holes and connecting it with the mill supply of cold water, and found his home made heater a success and his hopes realized.

Now with the original blow-off piped up and cock in place, as shown at I, and a long gage glass, as shown in Fig. 1, he had a heater that for several years

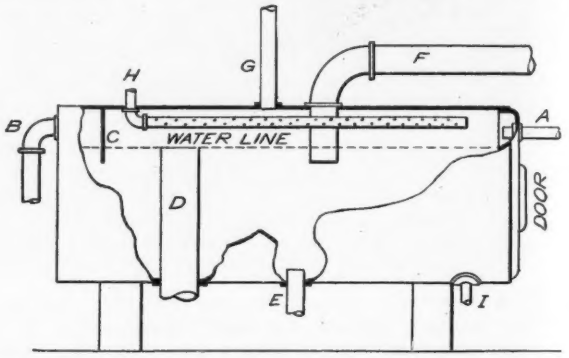


FIG. 2. SECTIONAL VIEW OF HEATER SHOWING INLETS AND OUTLETS

has supplied from 11 to 13 Cahall boilers with warm drink at from 175 to 220 deg. F. What little cylinder oil there is in the water floats off at the overflow and the sediment is prevented from entering the suction pipe by the short nipple extending in from E, Fig. 2.

By opening this novel heater once in 4 or 6 months and cleaning it out, scraping the shell and painting over with anti oxide paint, the heater keeps saving money for this engineer's employers and bids fair to last longer than its inventor; while he will not find it necessary to look for another position as long as the present employers need an engineer.

W. E. Chandler.

PUMP FRICTION

MANY engineers fail to realize the amount of power used up in running a pump with the glands tighter than necessary. It may be of interest to those having large pumps, to know the results of some tests on a unit having 1,500,000 gal. capacity in 24 hr. The pump was a cross-compound, Corliss valve, surface condensing with outside packed plungers, working under high pressure. Plungers were 8.5 in. diameter by 18 in. stroke. All the condensed steam used by the engine was caught in barrels on scales and gave the exact amount of steam used per hour.

Starting with the 4 glands loose enough to allow a leakage of 1⅛ per cent by weight, we got a duty of

117,000,000 ft. lb. Then tightening the glands so that there was little or no water leaking, the duty would drop off 3, 4 or even 5 million foot pounds. All other conditions were constant, head, steam pressure, vacuum speed, etc. We made several trials and obtained this result; weight of water pumped × rev. per hour × net lift × 1,000 ÷ steam used = duty.

As the amount of steam used rises or falls, the duty does the same, so by our catching more or less water at the barrel we learned what effect friction has on the duty. Twenty pounds more water caught in 1 hr. dropped the duty 1,750,000 ft. lb. The cards would also show a larger area which checked up with the water in the barrel.

Another fact was learned in connection with the steam duty, that applying kerosene to the plungers, by the hands the duty would rise; especially was this true where the surface of the plungers was gummy as it was after putting in new packing. Here we found a gain of over 1,000,000 ft. lb.

Another way we got at this friction was with a Venturi meter. In this style of meter the flow in the discharge pipe passes through a taper neck; a small pipe connection from each end of this neck is brought to the recording mechanism where with pen and ink the exact flow through this neck is recorded throughout the day. We found that running with 1⅛ per cent slippage at the plungers, pumping at a 1,000,000 gallon rate in 24 hr. the tightening of glands to no leakage, caused a falling off of 50,000 gal. per 24 hr. in the rate of flow. This extra friction by tightening caused a drop in speed and, unless the tension on the governor spring was changed, it would be several hours before the pen would return to its original position showing the 1,000,000-gal. rate. It was a very interesting experience and taught me to let a little water go to waste at the plungers as it is much cheaper than coal.—L. E. Worden.

GREASING NOISY GEARS

REFERRING to G. W. D.'s description of a pair of noisy gears and Practical Engineer's suggestion in the April issue of possible reasons for trouble and the remedy, the writer assumes that the gears in question are not cut, that is, they are plain casting, that they are bossed, keyseated and possibly the outer diameter of the teeth dressed up, and are running as nearly as possible to their pitch lines.

If this is so, part of the noise can be eliminated by using a liberal supply of gear dressing that will stay on the face of the teeth.

Having had trouble with noisy fast-wearing gears and having tried all the gear greases that had been offered the writer compounded an old dressing that was used on heavy gearing in Scotland about 30 years ago. It is made by melting together coal tar and beef tallow in proportions of 1-3 tallow to 2-3 coal tar. This compound will be rather stiff when cool, so should be warmed enough to flow freely when pouring it on the gears. While running, a thin stream given a lateral motion will distribute the dressing across the width of the face of the gears and if applied liberally and often enough for the first few days, it will by filling up the various depressions and coating the wearing surfaces with a tough cushion, remove a great deal of the noise and consequent wear of the teeth.

After having examined the pump end of the rig and G. W. D. is certain there is nothing there that would cause trouble, let him examine the governor mechanism on his Atlas engine.

If the governor is of the throttling type the valve stem in passing through the stuffing box may bind in the packing or the box itself. See that it moves freely and that the valve on the end of the stem does not bind in its cage. Sudden periodic opening and closing of this valve will cause the engine to jump at the gears as often as the sudden opening occurs.

If a shaft governor, the same result will follow if the mechanism does not work freely.

Whether the binding be in the pins, hangers, or other moving parts, or in the packing and alignment of the main valve stem, or in the valve balancing features contained in the steam chest, the sudden variation in speed consequent upon the jerky action of either type of governor will produce noise in the gears, even if they were well designed and properly cut. P. J. Keating.

PACKING OUTFIT

IN reading the letters in the April number of Practical Engineer, the packing cutter and table for sizes of packing by W. H. Stivason on page 244 particularly drew my attention and I would say that such a contrivance is

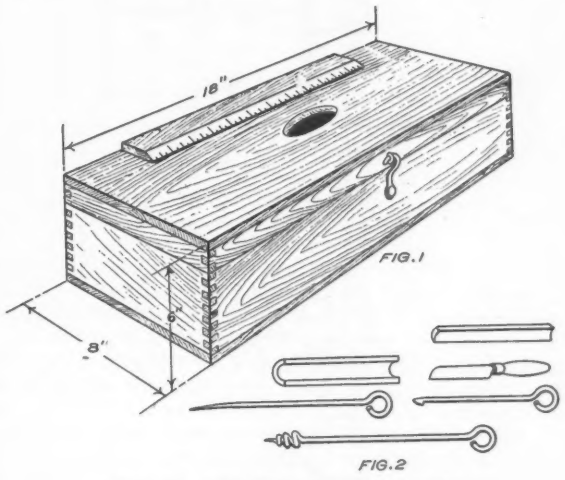


FIG. 1. BOX FOR PACKING OUTFIT
FIG. 2. PACKING TOOLS

a valuable adjunct to any engine room where space is permissible. The writer has since made a table for the sizes of rods from the copy that was shown. The illustration herewith presented shows a simpler outfit used by the writer, that is found to be quite satisfactory after many years' service, except for a new lid. In Fig. 1 is shown a box made of ¾-in. pine, 6 by 8 by 18 in. over all, with an ordinary 1-ft. straight edge rule glued to the lid. A hole is made in the center of the lid with which to carry the box and a list of the sizes of packing for the different size rods and valve stems is pasted on the inside of the lid.

In Fig. 2 is shown one of each of the tools used. At the right is shown a keen cutting cobbler's knife that can be obtained from the trade for 10 cents. The packing sticks are made from the staves of a discarded butter tub, in convenient lengths, the one shown at the left was made especially for deep boxes and is used for the ammonia pump. A small can of graphite and oil and a ball of asbestos cord are kept with the rest of the outfit in the box, ready to be taken to the job.

Jas. G. Sheridan.

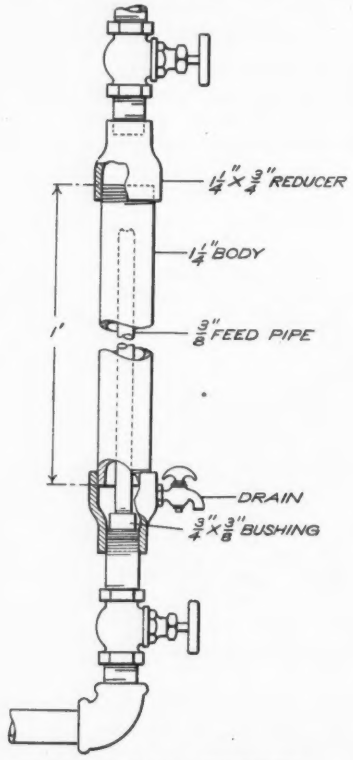
THE TRUE CHIEF ENGINEER will not hold his subordinates down by giving them inferior work to perform when they can do that which is more important.

HOME-MADE LUBRICATOR

AT one time, I was blessed with a lubricator that would not work properly on account of a derangement of its digestive organs. Somebody had taken it apart and injured the feed tube.

As the place was soon to be shut down for good, I would not be allowed any repairs that I could get along without, so I made an oiler out of old pipe fittings as shown in the sketch.

The body is made of 1.25-in. pipe about a foot long, reduced at either end to 0.75-in. The feed pipe was screwed into a bushing then the corners were filed off the bushing and screwed into the lower reducer against the lower end of the nipple as shown.



HOME MADE LUBRICATOR

The feed pipe was beaded in at the top and leaving a very small hole. Two globe valves are used as shown, also a drain plug. The principle is this: on opening the lower valve, steam passes into the oil chamber and is condensed, sinking to the bottom. As the oil is thus raised it flows down through the feed pipe and into the steam pipe.

It can be filled any time by closing the lower valve draining and opening the upper valve. I have used it some time with satisfaction.

I was amused by the article by Mr. Cadwell in the February issue on "starters and stoppers." I have seen men who were not eligible even to that class. I call them "heathen." I think it appropriate, because they haven't been converted to the calling. Any man who will reduce a 3.5-in. safety valve outlet to 1 in. or try to make a tight joint between flanges on a pipe line without using a gasket, or set a gasoline engine to fire when the crank is 30 deg. past center, or run every belt from the main driver to the governor belt with the flesh side to the pulley is surely a heathen.

Such men certainly never invest much in reading matter. I have spent $200 in the last 7 yr. for books and papers and I think it the best investment that I ever made or could make. I learn something out of every paper that I pick up, but I never expect to know it all.

Fred Eckley.

CONNECTING ROD WEDGE BOLTS

I NOTE in a recent number of Practical Engineer that O. L. H. desires information concerning wedge bolts. For his benefit, I will tell my experience along this line.

Some time ago I was doing the repair work in a paper mill and as the same trouble which O. L. H. had was experienced, I was, of course, informed of the difficulty. As the same kind of bolts had been used

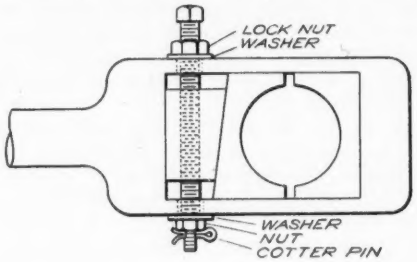


FIG. 1.—WEDGE BOLT IN PLACE
FIG. 2.—WEDGE BOLT

in each case to replace the broken ones, I thought it would be a good plan to try something else; so I made a bolt out of good soft steel long enough to go through the whole connecting rod, as shown in Fig. 1. I made the holes in the strap or rod plenty large and then put the boxing together. I was there 2 yr. afterwards and no bolt had broken yet.

When the brasses are worn sufficiently to allow the wedge to go to its extreme travel, it is set back and 1 or more sheet-steel plates are placed between the wedge and brass, not between the wedge and the frame; as there are flanges on each side of the brass where the wedge slides in, they will keep the sheet-steel plates or liners in place. Care should be taken that the plates or liners are the full size of the brass and fit nicely. To tighten the brasses, loosen the lock nut by turning it to the left, then turn bolt to the left, when tight enough tighten the lock nut.—S. L. S.

JOINT EFFICIENCY

I NOTICE that in your answer to J. H. K. in respect to safe diameter for boiler, in the February issue, you use an efficiency of 83 per cent for double lap joints. Permit me to say that an efficiency of 70 per cent is about the highest that can be obtained from joints of this kind and the writer has often found that they did not go over 65 per cent.

Thos. J. Hanna.

LEAD AND ECCENTRIC POSITION

IN the May number, page 317, L. W. B. asks, if an eccentric, having a 5-in. throw, be shifted ⅛ in. on a 15-in. shaft, how much will it change the lead? The question was answered on the same page, but it has occurred to me that as the question was rather general, perhaps the answer as given would not cover his particular conditions; so I will attempt a more general solution.

For the sake of space allow me to modify the numerical values, as follows:

Diameter of shaft, 3 in.
Throw of eccentric, 2 in.
Amount to be shifted, ⅛ in.
Steam lap, 0.4 in.
Present lead, 0.1 in.

These last 2 values must be known, and may be determined by measurement.

Draw a circle representing the shaft, whose center is C, to half size. With the same center and a radius equal to

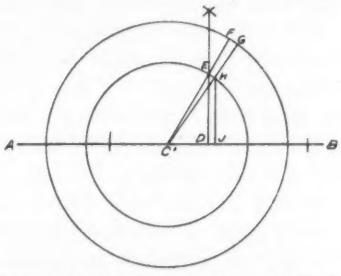


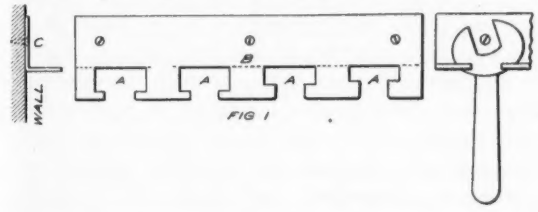
DIAGRAM FOR SHIFTING ECCENTRIC

half the throw of the eccentric draw a second circle which represents the travel of the center of the eccentric, and which we will refer to as the eccentric circle. Draw AB through C, and parallel to the eccentric rod, when the valve is at the end of its travel. On this line lay off CD equal to the steam lap plus the lead. At D erect a perpendicular to AB, cutting the eccentric circle at E, and draw CE, extending it to the circumference of the shaft at F. Lay off FG equal to ⅛ in., in the direction the eccentric is to be moved; draw CG, cutting the eccentric circle at H; then draw HJ perpendicular to AB.

DJ is the amount the lead will be changed, under the conditions assumed above, when the eccentric is shifted ⅛ in. measured on the circumference of the shaft. Of course if the ⅛ in. is to be measured at the center of the eccentric, it would have been laid off from E, instead of from F to G. J. M. Row.

RACK FOR WRENCHES

A HANDY wrench rack shown herewith is made by taking a heavy galvanized iron any length desired and width to suit the size of the wrenches which has openings cut as shown at A Fig. 1 for each



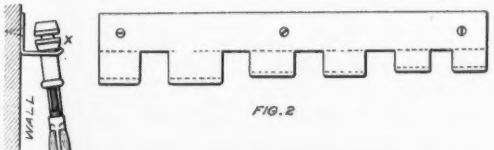


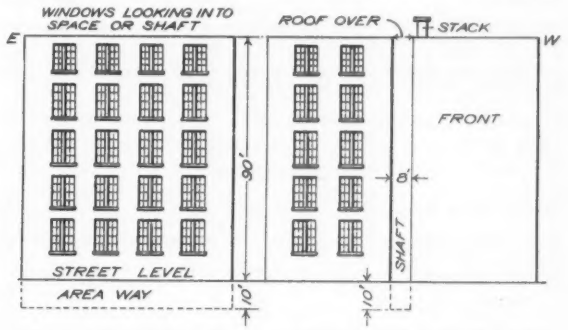
FIG. 1. RACK FOR SOLID WRENCHES
FIG. 2. SPECIAL RACK FOR MONKEY WRENCHES

particular wrench, and is then bent at right angles along the line B. It may then be secured to a wrench-board or wall of the tool cupboard by suitable screws, as seen at C, which shows an end view.

Another form of rack used for monkey wrenches is shown in Fig. 2. This is especially handy as a simple pull of the handle at right angles from the wall will release the wrench, as indicated at X. It is impossible to shake or jar a wrench from this rack, while it also has a neat appearance. An end view is shown at Y. J. S.

VENTILATION SCHEME

I SUBMIT herewith a plan proposed for ventilating our building, and would be glad to have the opinion of readers upon it. The building is about 90 ft. high by 52 ft. wide, and 135 ft. deep. Next door is a stack which throws out a large amount of soot, and we are compelled



SIDE AND FRONT ELEVATION OF BUILDING TO BE VENTILATED

to keep all the windows closed in the shaft between the buildings. It is proposed to cover the shaft at the roof, leaving front and rear of building open, or the shaft ends open, and open all the windows leading into this shaft, thereby drawing the air through the windows, or forcing air from the shaft into the windows, according to the way the wind blows. It is hoped by this to prevent soot and smoke from coming into the building.

My question is, if both ends of the shaft were closed as well as the roof, would we not draw air from our neighbor's window across the shaft, and in a calm or when little wind is stirring, will not this shaft form a pocket in which the air will circulate from floor to floor, according to the temperature? A high heat is discharged into the shaft from our neighbor's engine room. Is there any way to make this scheme of ventilation a success? W. L.

FIXING THE AMMONIA PUMP

MY ammonia pump cam rod broke and as we did not have another one on hand and it was in July, we were in immediate trouble. The rod broke near the crosshead, leaving enough threads to go half through a thick nut, so I screwed the nut on the end hard and fast, then took the nut out of the crosshead and screwed it in on the other side jam up, put the rod back, and it ran the rest of the year. Not a first-class job, perhaps, but it answered.

THE AUTHORS OF "A Holiday with the Birds," Jeannette Marks and Julia Moody (Harper Bros.), have aimed the book directly at the comprehension of children, using the terms they understand in telling them of "the kind of homes the birds like, the way they dress and fly, how they are made, and what they eat and how they breathe; of different birds in different families, of their aunts, uncles and cousins, and the long journeys thy take."

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OPERATING PROGRESS

Much difference of opinion has arisen at various times and much good gray matter has been wasted in trying to settle whether operating engineering is a trade, a calling or a profession. This arises as much as anything from the diversity of conditions under which the operating engineer works in different plants. From the little fellow, where the engineer shovels his own coal, does his own oiling, attends to all the shafting in the plant, dusts the office and mows the lawn, up to the central station, where the chief operating engineer spends his time in studying charts to find out where the last quarter of a heat unit got lost, is a long jump and it demands steady progress to step from one grade of work into another, for there is as wide a distance in grade between the first case and the last as between the man who is chipping castings and the man who is designing engines. The small plant as described represents the early beginnings. It is a comparatively infrequent type at the present time and is growing less and less frequent. On the other hand, the big central station is getting bigger and more of it and operating engineering must keep pace with this growth. The question then arises, Shall the operating engineers for these large plants come by steady progression from those men who are graduates of the scoop shovel college or must they come from the school-trained men by the addition of some years of experience in operating? The answer lies largely with the men in the engine room now. If they shall be content to let matters drift without effort to provide a definite means by which any man in the engine room may lift himself to the highest possible position in the profession, owners must seek the knowledge that they need from those who are school trained. Just now a movement is under way which, if given the support that it deserves, promises much for the elevation of operating engineering. Such a movement to be successful must be as broad as the country and those who are trying to get started are seeking this wide co-operation.

J. C. Jurgensen, who established a course of study of this kind in his own engine room at the Hotel St. Regis, and who, because of his success, was called to take charge of the classes in plant management in the evening technical courses at Columbia University, is responsible more than anyone else because of his interest in raising the standing and standard of operating engineering for starting the movement, and to give it some body, a temporary organization has been formed to do the preliminary work of calling a convention to decide what the Institute of Operating Engineers shall be and what it shall endeavor to accomplish. It is proposed that an organization shall be somewhat after this fashion:

The young man beginning his work in engineering may register as an apprentice with a local branch of the Institute and take up a course of study to be carried out along with his practical work. This study may be done in evening schools, by correspondence, by study of the technical journals and books, any way that best fits his needs and opportunities, so long as he gets the knowledge

which he requires to pass into the next grade. This is given the title of journeyman and the apprentice may pass to it at the age of 20 yr. if he can satisfy the officers of the local and of the Institute that he has served the proper time in a steam plant, machine shop or boiler shop and has acquired the knowledge specified.

If a man already has this knowledge and experience, he may enter at once as a journeyman and pass on to the other grades as rapidly as he can fulfill the requirements. From journeyman he passes to junior member, and then to full membership. The junior member must be 23 yr. of age, with the amount of experience and study required by the conditions of the Institute and must be awarded a diploma as operating engineer. Here again he may enter the Institute directly as a junior member, if he is of the right age and has the required experience. At the age of 30 the junior member passes to full membership if he has had the necessary service, knows the things that are required and is in actual charge of plant and men, either as chief or first assistant engineer. The associate members are those who are interested in the work, but are not directly engaged in operating engineering.

It is the hope of those interested in the Institute to make full membership a distinction which will be granted only to those who are fitted by the work they have done for a degree as important as the professional degree of an engineering school. At all points in the course it is the thought to have the studies contribute to the manhood as well as the engineering knowledge of the engineer, that he shall acquire something of the culture and broad-mindedness which are supposed to be given by the courses in engineering colleges, but unfortunately are not always, and that he shall become fitted to meet his fellow men of like standing in the community on a plane of equality; that he shall know more than the coal pile and the oil can, even in the apprentice stage and that as he comes to full membership he shall have a knowledge which will make him the equal of designing engineers, of electrical engineers and of the men in other professions.

Thus, the Institute, which would stand for the best interests of operating engineering at all points, would in its full membership grade be composed of men equal in every way to the men in the Institute of Electrical Engineers or the Society of Mechanical Engineers or the Institute of Mining Engineers, 3 sister societies which now have their headquarters in the same building as the Institute of Operating Engineering in New York City.

How the required training shall come to the members does not matter. In some cities, schools are already established which will be of the greatest assistance. To all the correspondence school courses are available and in many cases there are industrial courses either in the high schools or in the Y. M. C. A. buildings which will help greatly. It is not the intent, however, that a man with simply school training shall be permitted to pass without the actual experience. The man from the engineering college before he can enter any grade of the Institute must give proof that he has the required experience and the man who has come into the work of operating engineering from the practical side must by the same rule get the necessary scientific knowledge before he is taken into junior or full membership.

What will it amount to? That must be determined largely by the men who make up the great body of operating engineers throughout the country today. If it is true, as we believe it is, that the operating engineers of the country are among the most progressive, most ambitious and most earnest of any of the vocations, they will take the greatest pride in seeing that this movement for an Institute of their own, which shall be a great national body equal in rank to that of any branch of engineering, is given strong support and is placed from the start on a high plane.

The thought is not to make this a school for turning out engineers nor an easy process by which any man may obtain an engineer's license, but to give those men who want to make themselves fit for the biggest opportunities a well recognized route by which they may attain their object, getting assistance at all points and being guided along their path in the most efficient manner. The movement has the endorsement of the leaders in all organizations; the best men in the union ranks are for it; the best men in other engineering organizations, realizing that it will be a help to all organizations and a hindrance to none, are for it. While it will give solidity to the body of engineers, the thought is not to make this a social organization, but strictly educational and professional.

In two strong editorials, March 29th and May 24th, F. R. Low, of Power, has explained the principles of the Institute, and the requirements in order that full membership in the Institute may stand for what it should are particularly well stated. Mr. Low says rightly that if the first 100 certificates of full membership are awarded to men at the head of the profession, whose experience, attainments, personality and habits command respect for their vocation and for themselves, and the Institute maintains this standard as the requisite for full membership certificates, there can be no question about the success of the plan. A rigid standard lived up to, encouragement for all to try to reach this standard, and an effort to help them reach it, but a rigid refusal to grant the certificate to any who do not reach it, regardless of acquaintance or personal goodfellowship is absolutely necessary.

How this upholding of the standard shall be accomplished is for the convention which perfects the organization of the movement to decide, and it is for every engineer who honors his calling, who wishes to see it lifted beyond question to the rank of a profession and who would like to see his son have a chance such as the Institute will offer, even if he be not able to take advantage of it himself, to get into harness and help. Five dollars is the fee for charter membership and entitles you or the person to whom you may send your proxy, to a vote in saying what the Institute shall be and what it shall stand for. M. W. Rice is the secretary of the provisional organization, at 29 West 39th St., New York City, and is ready to give all information desired. The best men in the country are interested in having it organized right, and interests which ordinarily are more or less in competition and do not co-operate readily are forgetting their differences and working together for this end. The whole thought is to benefit to the greatest possible degree the operating engineers of the country. The only question comes, Are you of the operating engineers going to stand behind this? No body of men can rise unless it is ready to help boost itself and it lies with you of the engine room to say whether the time is ripe for the success of this promising movement.

IOWA STATE CONVENTION OF STATIONARY ENGINEERS

WHAT proved to be one of the most successful meetings of engineers ever held in the State of Iowa was the 7th Annual Convention of Stationary Engineers which took place in Waterloo on May 5 to 7, with headquarters at the Ellis Hotel. The date selected for this convention was opportune, as the factories of the city, some 100 in number, had their doors open to visitors during the week, and a large number of the engineers took advantage of the occasion and spent the entire week at Waterloo.

On Thursday the supply men put on exhibit articles and samples which are used in all branches of the steam-engineering profession and interested many of the boys in new apparatus and appliances which have recently been put upon the market. In the evening the first social event of the convention was held when the boys got together for a smoker in one of the elegant rooms of the Ellis Hotel. The supply men are adepts in the line of entertaining and it was not until an early hour that the boys parted for the night.

GROUP OF ENGINEERS AT THE IOWA STATE CONVENTION

Opening Session

THE first regular meeting of the convention was held Friday morning in the East Side Manual Training Bldg. The meeting was called to order by the state president, A. C. Willford of Waterloo, after which an address of welcome was given by the city attorney, M. H. Kelley, followed by a response in behalf of the engineers by F. W. Raven, national secretary, of Chicago.

The principal address of the morning was given by Mr. Willford, who outlined in a general way the work of the State Association of Stationary Engineers. He was followed by F. E. Cutler, president of the Board of Trade of Waterloo, who, though not an engineer, acted as one of the hosts and was instrumental in making the convention a success.

John A. Kerley, national trustee of the N. A. S. E., of Cincinnati, gave an address on the educational and fraternal value which one may receive as a member of the association. He also discussed at some length the advantage of having a state license law, requiring an examination of all engineers operating stationary power plants.

Following this were reports of committees, one of which was very gratifying to all members of the association. This was the report of the treasurer who announced that after all bills had been paid, a balance of $248.81 was still in the treasury. The report of the license law committee brought out the fact that Sioux City was the only city in the state which required a license of steam engineers. The committee went to considerable work in securing the opinions of owners and operators of power plants in Sioux City regarding the value and advisability of adopting the license law system throughout the state, and without an exception the letters received in answer to their inquiries were heartily in favor of the license law. Under such circumstances it was decided by the engineers at the convention to push this investigation and by every legitimate means possible endeavor to secure a state law requiring those in charge of stationary plants to pass satisfactory examinations.

Friday Afternoon

IN the afternoon, the second session of the convention was held when 2 lectures were given, the first on the construction and operation of a steam turbine, by C. M. Larson of the Union Electric Light Co., of Dubuque. Mr. Larson illustrated his paper by drawings, and discussed the construction and principles of steam turbines from the beginning of their history up to the present day. His paper was one of scientific value, explaining the theoretical principles involved in turbine construction, giving illustrations of the various types now upon the market, and discussing at some length a number of the difficulties which are met with in the operation and construction of this type of prime mover.

The second paper was presented by W. A Converse, secretary and chemical director of the Dearborn Drug & Chemical Works, of Chicago. The subject of this lecture was "Boiler-Feed Waters, What They Contain and Why They Contain Troubles." The lecture was given from the standpoint of a chemist, and a number of chemical demonstrations were performed which put the paper in such a form that any engineer familiar with boiler feed-water troubles could understand and appreciate the value of a thorough study of the feed water which he pumps into the boiler.

Feasting and Fraternity

THE principal social event of the convention was the banquet which was held Friday evening in the dining room of the Ellis Hotel. This banquet was given by the Waterloo boys to all delegates, guests and supply men. After the substantial part of the program had been finished F. W. Raven, acting as toastmaster, presented the speakers in his usual good form. Senator Moon of Ottumwa was introduced, and gave an invitation to the engineers to hold their next annual meeting at Ottumwa, promising them the advantages of the city and all other good things which the hospitality of the citizens could devise.

Other speakers of the evening were M. H. Kelley of Waterloo, John A. Kerley of Cincinnati, A. C. Willford of Waterloo, E. J. Doolitttle of Sioux City, F. E. Cutler of Waterloo, Austin Burt of Waterloo, and W. A. Converse of Chicago. Saturday morning the citizens of Waterloo acted as hosts of the engineers and took the boys around the city in automobiles showing them the many places of beauty and manufacturing facilities of the city. After several hours of sight seeing the boys convened again in the Manual Training Bldg. to listen to a paper on alternating currents, read by Austin Burt, general superintendent of the Citizens Gas Co. of Waterloo. The paper was illustrated by an adjustable chart, showing phase relations, resultant current, and voltage, and other characteristic features of alternating current combinations.

Officers and Meeting Place

AT the last session of the convention, held Saturday afternoon, the business was electing officers for the coming year, and discussing plans for future development. It was decided to hold the next meeting at Ottumwa and newly elected officers are as follows:

H. T. Yust, Ottumwa, president; S. C. Dyke, Dubuque, vice-president; Geo. H. Beebe, Marshalltown, treasurer; James A. Coulson, Sioux City, secretary; J. L. Rockwell, Sioux City, conductor; Wm. D. Ryan, Waterloo, doorkeeper. E. J. Doolittle, of Sioux City, was recommended for state deputy. The next annual convention will be held at Ottumwa, and everyone who attends is assured of a pleasant as well as profitable time.

Exhibitors at Waterloo

DURING the convention representatives of the various supply houses were much in evidence at all the meetings and social functions. The billiard and pool hall in the Ellis Hotel was converted into an exhibition room where the supply men displayed their various lines and gave away many souvenirs which had direct reference to the products manufactured.

C. E. HUNT of Eagle Grove, Iowa, exhibited the Hunt Commutator Turning Machine, a new device recently put on the market which is attachable to any generator or motor, and operates without the necessity of removing the armature from the machinery.

THE SCOTT VALVE CO., of Chicago, had on exhibition a Marsh Steam Pump, which is the product of the American Steam Pump Co., a Sorge Exhaust Head, and a full line of Scott valves. C. M. O'Brien was the representative for the American Steam Pump Co., and E. A. Evers represented the Scott Valve Co.

THE MONARCH STEAM BLOWER CO. showed the operation of the Monarch Blower and had an able representative on hand to explain the many points of advantage from use of this apparatus.

ADAM COOK'S SONS had a real live booster present in the person of Geo. A. Wellington, who displayed a full line of Albany Grease and showed how easy it is to slide into economical ways by the use of this excellent lubricant.

SAFETY VALVES, steam gages, indicators, indicator reduction apparatus, planimeters, draft gages, etc., made by the American Steam Gauge & Valve Mfg. Co., were artistically arranged and displayed by Chas. C. Filander, a representative of the company.

JENKINS BROTHERS were given live representation in the person of J. H. Williams who displayed a full line of brass globe and angle valves, made by Jenkins Bros. and distributed samples of Jenkins Bros. '96 packing.

BOILER COMPOUND made by the Hawkeye Compound Co., was given prominence during the exhibit by R. M. Rochfort, and none of the engineers present went away without knowing its good qualities.

THE LUNKENHEIMER CO. never fails to be represented in state conventions, and its exhibit in Waterloo was one of the most complete in the hall. The company manufactures a line of special bronze supplies and had on exhibit Duro blowoff valves, oil pumps, oil and grease cups, Renewo valves, nickel seat non-wire-drawing valves, all made of its special bronze. The company presented the Waterloo boys with a design which shows in cross section a number of the most interesting articles manufactured by this company. It also exhibited Nonpareil generator valves and other accessories for gasoline and gas engines. A series of conventional blueprints of valves made by the company were also explained by their representative, E. P. Gould, who was in charge of the exhibit.

LYONS BOILER WORKS exhibited a small model boiler made with a glass cylinder and fired by gasoline torch which was one of the most attractive articles on exhibit in the exhibition hall. W. P. Lyons was the chief engineer who instructed the boys when to operate the blowoff valve and the steam whistle, and also the method he used to feed Buckeye boiler compound into this efficient boiler.

THE LARGEST STEAM TRAP ever brought into the state of Iowa was on exhibit by the Morehead Mfg. Co., which was represented by Chas. Menges of Wichita, Kans. This trap is the No. 5 which has 2½ in. connections. In contrast with this apparatus was a small nickel-plated Morehead model trap which attracted attention for its completeness of design.

THE WM. POWELL CO. had a stand in the exhibition hall, where the advantages and various good features of Powell White Star valves were ably discussed by Chas. Menges, western representative of the company.

SHEET RING HYDRAULIC and varions other forms of packing made by the Crandall Packing Co., were strongly in evidence at the convention, partially because of the good qualities of the packing and partially due to the live representatives on the ground in the persons of W. F. Ebert, and C. J. Vailes.

THE ANCHOR PACKING CO. was there with a neat and complete display of its rubber, asbestos, graphite, metallic, and other forms of packing, which are used about the power plant. Those on hand to give information in regard to these articles were E. Elphick and J. B. Philp.

THE H. W. JOHNS-MANVILLE CO. is always well represented in conventions, and at Waterloo had

a full line of asbestos packing, special plumbing equipment, asbestos roofing, shingles, pipe covering, electrical insulation, and sundry materials. C. S. Padgett from the Milwaukee office had charge of the exhibit.

THE ENGINEERING SPECIALTY & MACHINERY CO. exhibited the Copes boiler-feed regulator made by the Northern Equipment Co., and the Swartwout line of power plant accessories. J. B. Philp represented the company and was fully equipped to tell of the advantages and economical operation of the apparatus under his supervision.

RALPH H. RAWSON had charge of the exhibit of the McMaster-Carr Supply Co., which displayed a line of steam specialties and rubber goods, belting and packing.

THE FISHER GOVERNOR was given considerable publicity and became quite popular among the engineers because R. B. Reasoner was the able representative of the Fisher Governor Co., and presented a line of argument which no one could get around.

QUAKER CITY RUBBER CO. exhibited Daniels PPP packing and Ebonite, samples of which were given out by the jolly and well known representative, Harry E. Dennie, who did not let one minute go to waste.

GARLOCK PACKING has no equal, according to the statements of H. W. Irons, the able representative of the Garlock Packing Co., who had on exhibit a line of sheet packing which took the eye of the engineers who visited the exhibit.

WESTERN VALVE CO. which supplies the trade with Fairbanks valves, Pratt & Cady valves, Pratt & Cady asbestos packed blow-off cocks, fire hydrants, valves for high steam pressure, etc., had an interesting display of its products on exhibit in charge of Quay T. Stuart.

THE KEYSTONE LUBRICATING CO. was ably represented by F. W. Armstrong, who stood ready to solve any lubricating problem which was presented to him by the boys who have had them.

THE DEARBORN DRUG & CHEMICAL WORKS was one of the most popular exhibitors at the convention, being represented by O. E. Poole, F. C. Gibbs, and W. A. Converse. The company distributed souvenirs in the form of bill books, and at the banquet presented each guest with a small bottle of perfume, the product of the company.

THE STANDARD OIL CO. never fails to have a representative where its products are in use, and in Waterloo, John D. Stuart was the prime mover of the company.

OSBORN MONNETT represented Power and the Engineer.

THE UNDERFEED STOKER CO. of America had its eastern representative, C. K. Sherman, to explain the merits of the Jones Underfeed Stoker to all interested engineers, and was the only concern who used the American Flag in decorating its booth.

DIAMOND COMPOUND and Lubriko lubricants made by the Commercial Lubricating Co. were given prominence by J. E. Dickover.

J. C. TELLER of the Teller Furnace Co., was on hand to explain the advantages of using the Teller Air-Burning Furnace which has recently come upon the market.

CUTTING YOUR COAL BILL in 2 was fully explained by H. M. Jones, who represented the Murray Iron Works Co., builders of Corliss engines, all types of boilers and complete steam plants.

MASSACHUSETTS STATE CONVENTION

AS previously announced in Practical Engineer, the Massachusetts State Association N. A. S. E. convention will be held this year at Lowell on July 7, 8 and 9, and from present indications promises to be the best yet held by that body, which has the reputation of doing things and doing them right. The committee from Lowell No. 17 is hard at work to make it a success.

A large hall for the use of the exhibitors has been secured in the center of the city and booths will be erected and everything done to make it pleasant and profitable for the exhibitors. Lowell is a city of over 100,000 inhabitants and contains some of the largest textile mills in the country.

Space for exhibitors is rapidly being engaged and those wishing space should secure what they want at

MASSACHUSETTS STATE COMMITTEE—BACK ROW STANDING COMMENCING ON THE LEFT: H. W. YEOMANS, A. L. MERTRUDE, M. E. POWERS, R. W. VAN TASSEL, W. E. SARGENT, WM. GOULD, O. M. DOW, J. W. LAYCOCK. SEATED: W. H. QUIGLEY, JOSEPH COLLINS, SECRETARY; T. N. KELSEY, PRESIDENT; GEO. CHAMBERLIN, VICE-PRESIDENT; E. C. PRATT, TREASURER; I. F. MOULTON, M. J. DONOHOE

once, if they would avoid being disappointed. Joseph Collins, secretary, 10 Varney St., Lowell, Mass., will give full information.

AT THE MEETING of the National Gas and Gasoline Engine Trades Association, to be held in Cincinnati, June 16, an exhibit will be held of engine parts and accessories in the hall adjoining the convention hall at the hotel. Entertainments have been provided for those attending the convention, but the details are not yet fully settled. The papers which will be read at the meeting will be Carbureters by Geo. M. Schebler, Ignition in Gas and Gasoline Engines, by Chas. Pfanstiehl; Gas Producers, by L. F. Burger; Present and Future Opportunities in the South for the Gas Engine Builder, by W. R. C. Smith; How to Illustrate and Describe Mechanical Installations, by O. Monnett; Heavy Hitting in the Advertisers' League, by Ren Mulford, Jr.; Some Association Experiences, by F. J. Alvin; Dry Batteries by H. S. Green; The Gas Engine Field in Mexico, by G. W. Hall; and Large Gas Engines by J. D. Lyon.

WICKES BOILER CO., whose factory is at Saginaw, Mich., has just opened a new office at 410 White Building, Seattle, Wash.

BOILER EXPLOSION AT CANTON, O.

IN THE PLANT OF THE AMERICAN SHEET & TIN PLATE CO.

ABOUT 2 p. m. Tuesday, May 17, a loud report and a thud that was heard for several miles surrounding the plant, brought the citizens running into the streets to detect the cause of the noise and shock. The fire alarm immediately rang and the news spread like wildfire that a terrific explosion had taken place at the Rolling Mill on Harrison Ave., the local mill of the American Sheet & Tin Plate Co., and that many were killed and injured.

FIG. 1. CONDITION OF THE PLANT AFTER THE EXPLOSION

The Timken Roller Bearing & Axle Co., The Cleveland-Canton Spring Co. and Goheen Paint Co., in the immediate vicinity, closed down their plants and sent men over to the mill to help with the relief work. All the ambulances and physicians that could be procured were pressed into service and all the delivery wagons and automobiles were secured. Homes in the vicinity were thrown open for the injured to be cared for until they could be sent to the hospitals and those that could be were taken to their homes.

At this writing 13 dead are reported—all identified except 1; 2 are unaccounted for and 32 injured, several perhaps fatally.

The body that could not be identified was blown about 500 ft. and struck the side of a house just under the roof, passed entirely through the house, coming out on the other side, went across the street and struck a paling fence, which stopped it.

Another man was blown about 1200 ft. north of the plant along with the shell of the boiler which was blown over the top of the Goheen Paint Co.'s plant. The force was so great that this piece of boiler when striking the ground plowed a gutter about 2 ft. wide, 18 in. deep and about 35 ft. long, finally landing in a man's back yard. This piece of boiler weighed in the neighborhood of 4500 lb. The sheet in this piece of boiler showed considerable pitting and wasting away of material; some of the braces apparently were not in as good condition as they might have been in the judgment of the writer.

The whole plant is practically a scrap yard. At this date it is impossible to get detailed information as the company is guarding the grounds closely and allowing only officials of the company on the grounds. Some of the boilers are moved only a short distance. There were 7 boilers in the battery and 3 are reported blown up. One boiler was blown about 250 ft. north of the boiler room. There were some braces and tubes found as far away as 1000 ft. from the boiler room.

All the boilers were return tubular, 6 by 18 ft. The head end of one boiler blew across the street up against the porch of a house. This piece had 70 4-in. tube holes, and was about 2/3 doubled, 1 brace (in the judgment of the writer) had a flaw or a crack about 1/3 the depth of the brace and across the width of the brace just where the brace made the bend to leave the shell for the head end of the boiler.

The writer did not see the boiler until the morning following the disaster and as the evening of the explosion it rained all the fractures were newly rusted, which made it impossible to determine absolutely whether they were old or new fractures.

The Coroner's experts declare that the boilers were in bad condition. The company is applying the relief provided for its employes on the first of May. They are taking care of all the injured and providing necessary relief for the families of the deceased.

As is usually the case in an explosion, the reports from different sources are in wide disagreement. For

instance, Edward W. Whelan, an expert on steam boilers who is acting with the coroner in investigation, found that boiler No. 5 is still imbedded in its foundation, while Nos. 1, 2 and 3 are gone. His opinion is that the explosion was due to a lack of water in the boiler, as the flues show that scale had been burned off, showing red iron. A portion of No. 2 boiler which was examined showed that the boiler iron had been sheared off the rivets. Several of those employed about the plant state that the boilers were old and had been in use for a long time. The plant had been shut down for a number of years until a short time ago.

One of the water tenders, Bradley by name, states that 2 weeks before he had made some repairs on No.

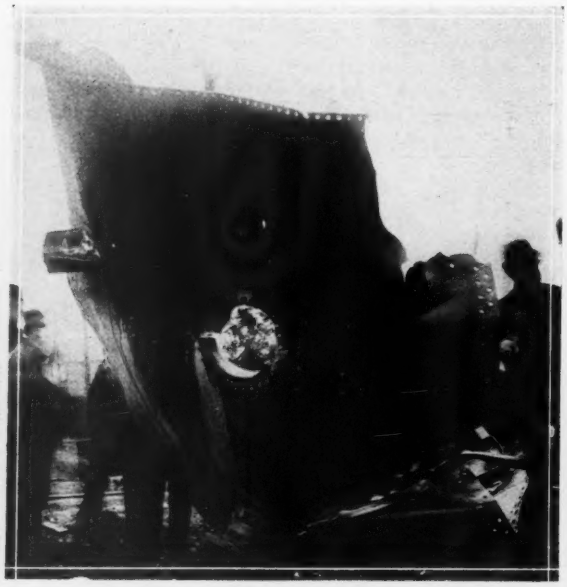


FIG. 2. SHEET FROM THE NO. 2 BOILER

2 boiler and put some marks on it which he found on the section of the boiler which was blown out of the plant. He is of the opinion that No. 2 boiler gave way and started the others. He states that the blowoff on No. 2 was broken and that the steam pressure dropped from 90 lb. to 40 lb. in a few minutes.

On the other hand the superintendent states that the boilers were new 7 months ago, that they were inspected on January 10, by the Hartford Boiler Inspection Co., and were allowed to carry 100 lb. pressure. He says that the safety valve was set at 95 lb. and was tested every day.

Chief Engineer Wm. Yusson states that the plant was in good condition and that the boilers were new only 7 months ago, that none of them had been condemned and all were working at the time of the accident. Some trouble had been experienced with the engine on Monday. Bradley's statement is that there was trouble with one of the boilers Tuesday morning and Whelan states that Nos. 1, 2 and 3 were unsafe, that the bottom sheets were thicker than the top sheets and that the safety valves on all boilers popped at 100 lb., while neither No. 2 nor 3 should have stood more than 75 lb., and that any inspector could have seen their dangerous condition.

The coroner's investigation is still under way and it is probable that out of the testimony some facts will be established in regard to the condition of the boilers, but whether the cause of the explosion can be determined is a matter of great doubt. The testimony of witnesses is taken from the newspaper reports and is, of course, to be judged with some discrimination.

CONNECTICUT STATE ENGINEERS

THE Connecticut State Convention of Engineers will be held in New Haven, June 24 and 25. New Haven has 150,000 inhabitants and is a center for the purchase of supplies for the whole state, so that firms exhibiting at this convention will get a wide publicity. The convention will be held in Engineers' Hall, Bordman Building, and space will be provided for those desiring to exhibit steam specialties and power plant supplies, every effort being made to have this feature of the convention a big success.

Convention meetings will be held in the same building, thus insuring large attendance at the exhibits. The exhibition will open at 10 a. m. on June 24 and continue to 6 p. m. June 25. Business sessions of the convention will be called to order at 9 a. m. June 24 and adjourned until 8 p. m. the same day, the evening being taken up with reports of committees and speech making.

On June 25 the convention will meet at 9 a. m. and continue in session until all business has been completed and new officers elected. The convention will close with a Shore Dinner and ball game between delegates and guests. Those desiring to make an exhibit should notify the state secretary, Henry Vanderburgh, 24 Woodbridge Ave., East Hartford, Conn., as early as possible, so that arrangements may be made. Convention headquarters will be in the Garde Hotel.

NEWS NOTES

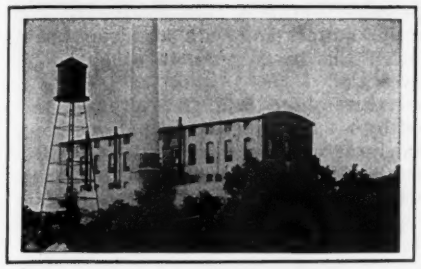
ON MAY 1 the Alberger Condenser Co. and the Alberger Pump Co., of New York City, removed their offices to the West Street Building, 140 Cedar St., a change made necessary by the increased business of the 2 companies.

F. C. BUKLEY, manager of the Sterling Lubricator Co., left on April 30 for a business trip to England and the European continent.

THE INTERNATIONAL ACHESON GRAPHITE CO. has established branch offices in important cities to take care of the growing trade in its products. At room 511, West Street Bldg., New York, is an office from which every effort will be made to promptly supply the Eastern trade. A branch office has been opened at 457 Monadnock Block, Chicago, Ill., from which the company's interests in the Middle West will be cared for; and in order to meet more promptly the demands of the trade in and about Pittsburg the company has established a branch office at No. 309 Fourth Avenue.

J. B. BELL, who has been in charge of St. Louis business for the Russell Engine Co. for 2 yr. and has made a most creditable record, died on March 24 last. The company's interests in the St. Louis Territory will be looked after in future by John E. Angell & Co., Security Building. Mr. Angell is a practical engineer as well as being technically trained and has a wide experience in the engineering field so that he is thoroughly competent to advise on engineering problems with respect to engines, feed water heaters, etc.

ON MAY 5 the Chicago office of the Pennsylvania Flexible Metallic Tubing Co., was removed from 255 LaSalle St., to the Peoples Gas Building, 150 Michigan Blvd. The new telephone number of the company is Randolph 2446.



Power Apparatus

In Shop and Market

New Ideas in Making, Buying and Selling

SIMPLICITY WATER SOFTENER

By Chas. C. Patton

IN AN institution like a big hotel, with the hosts of guests and large demands for water, the supply required varies greatly at different times of the day and any system of water softening must be sufficiently large to meet the maximum demand. The builders of the Simplicity water softener guarantee to soften a given amount of water in less time and at less expense than by any other means, which is a strong argument in favor of its use. There is no question but what a softening plant is a good investment for anyone who has to deal with hard water, and in the case of the Chittenden Hotel large saving in fuel and almost entire elimination of boiler cleaning and repairs have resulted.

The plant was installed of ample capacity to meet the requirements for both the power plant and the house service, and has proved in all respects eminently satisfactory. As its name implies, the apparatus is designed for simplicity and to meet the requirements where space occupied, operating expense, and cost of pumping water are factors to be considered.

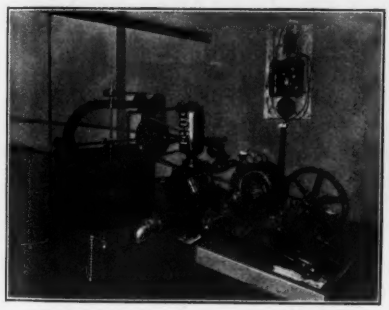


FIG. 1. THE SIMPLICITY WATER SOFTENER

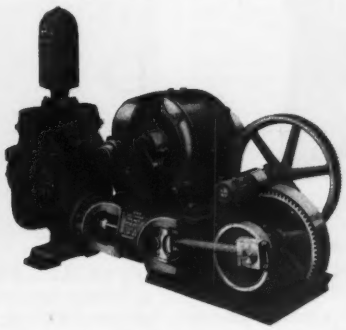


FIG. 2. WEINMAN PUMP INSTALLATION

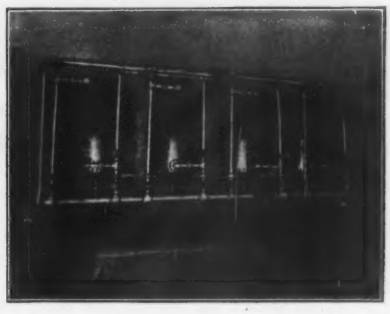


FIG. 3. THE FILTERS OF THE CHITTENDEN HOTEL INSTALLATION

Figure 1 shows the installation where the water is handled with an electric driven pump, the pump unit being furnished by the Weinman Pump Mfg. Co., of Columbus, Ohio. The pump unit is provided with automatic pressure regulator and self-starter, and has variable speed control of the motor, an arrangement which places the entire plant within easy control of the operator and gives uniform pressure and service. This pump draws water from the original source of supply and forces it through the softener and filters, delivering pure water where desired. It has a capacity of 75,000 gal. of water a day. The dimensions of the pump cylinder are 6 in. diameter by 8 in. stroke, and the motive power is a 7.5-hp. Imperial Electric Co. motor of variable speed type.

The settling tank is steel, 6 ft. in diameter by 32 feet long, of ⅜-in. steel, the heads being of ½-in. It is located in the basement and arranged to secure the best settling action of the mixture and connected to the filters, which are 4 in number, 36 in. diameter, 72 in. high and fitted with necessary valves for ready washing.

The system is made by the Simplicity Water Softener Co., of Columbus, Ohio, the patents being obtained and owned by J. T. Lemon, Columbus, Ohio. The softened water from the system, both hot and cold, is used all over the hotel for baths, washstands, laundry and boilers. Distilled water is used for drinking purposes so that no city water is used in the hotel at all.

ROTO TUBE CLEANER HEAD

RECENTLY The Roto Co., Hartford, Conn., manufacturer of boiler tube cleaners, has brought out a new cleaning head which presents some interesting features.

The general construction is evident from the accompanying cuts, and among the points of greatest interest will be noted the following:

Movement of the cutters always parallel to their work; greatly increased cutting capacity; rivetless, all steel construction with the entire absence of small parts, such as pins, trunnions, etc.

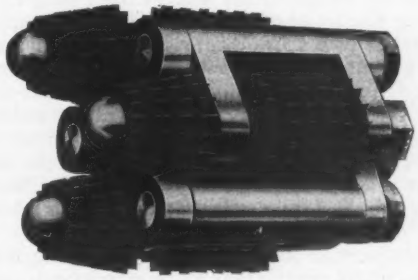


FIG. 1. THE ROTO SWING FRAME HEAD

For quick repairs the head is taken apart by simply unscrewing it from the motor shaft and without tools. Great strength with light weight is had by supporting

the swing frames in the spider and the cutter bolts in the swing frames at both ends. Durability is assured by employing only true surface bearings, and by the absence of line contact between wearing surfaces.

The construction brings the cutters well back and close to the motor, or causes the motor to follow close behind the cutters and no time is lost in pulling the cleaner back and forth in the boiler tube to find scale located between the motor and the cutters.

This new head has been developed to get the full benefit from the speed and power of the new Roto Positive Action, Balanced, rotary motors, and is claimed to have amply demonstrated its ability to absorb and utilize the full power, and to stand the strain and wear of the hardest service while thoroughly removing all scale right down to the metallic surface.

Figure 1 shows the head ready to screw on to the motor, Fig. 2 the steel spider with hinge bolts in place. It is a solid piece of crucible steel with end flanges or arms to support the swing frame at both ends. The central stem is of triangular section to allow the use of very large cutters. On the standard 4-in. head, cutters up to 1½ in. diameter can be used.

Figure 3 shows one of the spring frames, armed with cutters, ready to be placed in the spider in a few seconds and without the use of tools.

A retaining ring (not shown) slides over the hub of the spider and holds the hinge pins into place, at

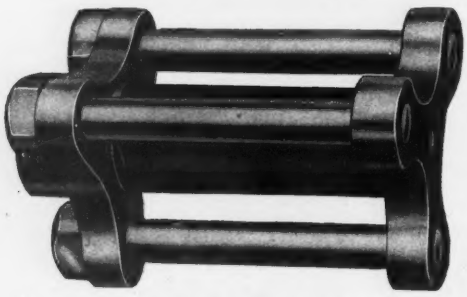


FIG. 2. STEEL SPIDER AND HINGE BOLTS

the same time holding them from turning, with the result that there is absolutely no wear of the spider itself.

A shoulder on the motor shaft bears against the retaining ring and thereby holds the entire structure together, continuously tightening by the efforts of the motor at work.

The cutter bolts are usually large (7/16 in. diameter) and are screwed into the rear leg of the swing frame against a shoulder, and with a right hand thread which tightens by the action of the cutters. The outward movement of the swing frames is limited by stops forged solid on the under side of the swing frame, and engaging the finished internal hubs of the spider. As the cutter bolts do not turn in the swing frames, all wear is confined to the very hard and cheaply renewed cutter bolts.

When the head is to be used without removing the rear caps from the boiler headers, a "bumper stem" is furnished projecting from the front of the spider to prevent the head going clear through the boiler tube, a very simple device which proved a great convenience.

In the operation of this head the swing frames are thrown out by centrifugal force; the advance cone cutters attack the shoulder of scale, while the cutter wheels thoroughly remove the scale and polish the boiler tube. The always parallel movement of the cutter insures each cutter doing its full share of the work. It is claimed that this combination of cone cutters with parallel cutters and with an always parallel movement makes this head rapid, thorough and effective on heavy scale.

Steel is used throughout and all parts are thoroughly hardened by a special process which combines both wearing hardness with toughness for strength.

The standard 4-in. head carries (without cutter washers) 33 cutter wheels and 3 cone cutters, and has a total cutter length of more than 8 in., yet the complete

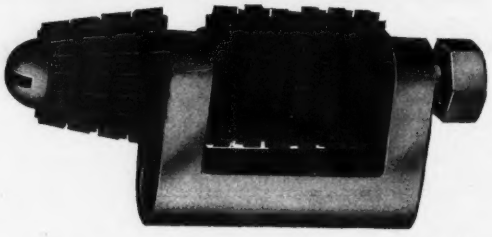


FIG. 3. SWING FRAME ARMED WITH CUTTERS

head weighs only 4¾ lb. complete with cutters, or 3 lb. without cutters. This is an unusually large proportion of cutter weight.

The manufacturing company makes very strong claims for the speed, thoroughness and durability of this new head, and it appears to be a development from the survival of the fittest in a long experience of heavy duty tube cleaning.

LUBRICATION BY THE USE OF MICA

PUTTING down the friction losses in a plant is one of the difficult problems of the engineer. Needless to say, the same kind of lubricants will not answer equally well for all kinds of bearings. A high speed bearing with high pressures requires a very different oil from a slow-running bearing carrying a high pressure, and for other places other lubricants are better than any oil. A hot journal is a bugbear which every engineer dreads, and a supply of Mica Flake Lubricant has in many cases proved a cheap insurance against loss of time and products due to this cause. A little of the Mica Flake mixed with oil or grease and used all the time has been found to cut down the cost of lubrication materially.

The flake enters the cracks and pits which may appear in the rubbing surfaces and fills them to a smooth, even surface, thus giving a degree of smoothness of running not obtainable when the surfaces of the metals themselves are in contact. It is absolutely cleanly and no abrasion of metal takes place when it is used. Only a little of the flake is needed, 3 to 6 ounces in a gallon of oil being plenty, so that the cost is very small. The mica is so light that it will be carried in suspension by the oil or it may be applied absolutely dry, but in this case a very small quantity should be sprinkled on the bearing after the oil is applied. For use with grease, 1 part Mica Flake to 3 parts grease is the proportion recommended. Tests made by the Mechanical Department of Armour Institute of Technology showed that with the addition of 5 per cent of mica to a lubricating oil the pressure could be doubled without heating of the bearing, and the oil would last nearly 4 times as long as when used alone.

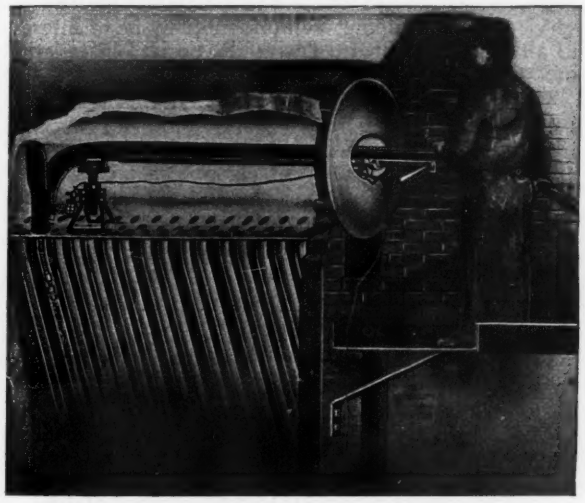
This new lubricant is being introduced by the United States Mica Co., 238 La Salle St., Chicago, who will furnish further information.

CLEANING STIRLING BOILERS

NO one doubts the good steaming qualities of Stirling Boilers but in removing the scale from their tubes it has been necessary to have a man crawl into the drum, sit cramped up in an uncomfortable position, and run a turbine cleaner through each tube. It was also necessary to have a helper on the outside to turn the water or steam on and off.

All this discomfort and inefficiency in cleaning this type of boiler has been rendered unnecessary by a new device recently perfected by the Lagonda Mfg. Co., of Springfield, O. The accompanying illustration shows how this device is applied and used. The man stands outside of the boiler in a comfortable position and can regulate the steam or water supply himself, thus doing away with the extra wages and time of an assistant.

The device consists of a sectional trough arrangement having a funnel at the far end for guiding the



LAGONDA DEVICE FOR CLEANING STIRLING BOILERS

turbine into the tube. The trough is supported on the edge of the manhole at one end, and by a special tripod over the tubes at the other end. This tripod can be easily moved around at will, thus allowing the cleaner to be shifted from one tube to another. The operator places the funnel over any tube he wishes to clean and starts to feed the cleaner in, the rate of feeding being determined by the amount and character of the scale. In feeding in the cleaner, the operator is guided entirely by the ear and touch, but he would have to be guided this way anyhow, even if he were on the inside, as on account of the curvature it is impossible to see through Stirling boiler tubes.

After cleaning one tube the tripod is shifted to the next one and the cleaner fed in as before. It should be noted that when the supply hose is filled with water it becomes rigid enough to force the cleaner at any desired rate.

As the trough arrangement is made up of short lengths which snap together, the device can be used in very cramped quarters. There are no obstructions or guides on top of the trough and the cleaner and hose can at any time be withdrawn from the drum and the cutter wheels renewed or the turbine inspected.

It has been found that by using this device the time consumed in cleaning Stirling boilers is greatly reduced and the cost of a helper is eliminated. It also ensures a first-class job to the owner. Further information concerning this device can be obtained from the Lagonda Manufacturing Company, Springfield, Ohio.

CATALOG NOTES

METAL HOSE is a most desirable article for handling steam, oil, air and other fluids under the highest pressures, if the hose is so made that it holds tight. The interlocking metal hose made by the Pennsylvania Flexible Metallic Tubing Co. is the kind that does stay tight and the uses for which this durability and security have made it available are illustrated in a booklet just from press showing its adaptability to air brake connections, turbine cleaners, handling of oil in cars, wagons and boats, vacuum cleaning, the handling of gas and other industrial operations. The catalog shows also the connections for the tubing. Copies can be had from the company at Philadelphia or any of its branch offices.

EXAMPLES OF HOW A BELTING can deserve as well as have the name "Duxbak" make up the exhibit of the Chas. A. Schieren Co. at the International Exposition now being held at Brussels, Belgium. Descriptions of the different exhibits are given in pamphlets which are now being issued, one in French and one in German, for use at the exposition. As soon as the Belgium exposition is completed the exhibit will be moved to Turin. These booklets, besides showing the different transmission arrangements of the exhibit, give an idea of the European offices which the large and growing business of the Schieren Co. make necessary. The exhibits are, first, a proof of the waterproof qualities of "Duxbak" showing a belt transmission running with a spray of water constantly falling upon it, a practical proof that water, dampness, cold and temperature change have no influence whatever on the leather or on the joints. The second demonstration is a "Duxbak" belt connected with Lenix belt tightener having a very short distance between shafts, very small pulley dimensions and a small belt and noiseless working. The third transmission shows the belt running half crossed. The fourth is an example of the "Duxbak" belts used for textile mill installations, the drive for the looms being operated with very short centers between shafts. The fifth example is for a ceiling arrangement of the belt with double tighteners and direction pulleys. The sixth exhibit shows the most efficient method of conveying power between 2 crossed shafts by means of belting. It is a substitute for the bevel gear, doing away with the noise and insuring a greater power output. Transmission No. 7 illustrates the drive for a centrifugal pump using the "Duxbak" belting and the Lenix tightener. Besides driving over a very sharp turn the belt is operated by a shifter. The eighth example shows the belt half crossed, working on a cone pulley with speed regulator, an outfit which is convenient for spinning mills and by which the speed can be changed while the machine is working. It avoids the use of the disconnecting fork and results in longer belt life.

TO THOSE NOT ACQUAINTED with the Weinland Quick Repair Head an introduction may be had by writing to the Lagonda Mfg. Co., of Springfield, Ohio, for its attractive pocket catalog called Introducing the Weinland Quick Repair Head. It tells about other interesting specialties that the Lagonda people make also.

BRISTOL'S ATMOSPHERIC RECORDING THERMOMETER and other recording types are

shown in Bulletin No. 124 of the Bristol Co., Waterbury, Conn. This apparatus shows at any desired point the actual continuous record for temperature day and night on a chart which may be revolved once in a week or once in 24 hr. This will record temperature wherever the thermometer bulb is located. The bulletin shows how it operates and also the different styles of charts which may be had with the apparatus. It is one form of the numerous family of Bristol recording instruments which have been adapted for use in all industries.

FOR THE CONVENIENCE of those operating gas engines the International Harvester Co. of America publishes the Engine Operator's Guide which tells about installation and adjustment of engines, how to locate and correct troubles of starting, ignition, cylinder valves, fuel supply, leaky gaskets, water jackets, the general routine for care of an engine and the points to be considered in purchasing. It is a well worth while book for anyone interested in gas engine operation.

CURTIS ENGINEERING SPECIALTIES cover a large list of useful devices for the power plant. Among them are the Improved pressure regulator for steam, the Curtis water pressure regulator, the Improved pump pressure regulator, the Curtis expansion trap, the Curtis balanced trap relief valves for steam or water, the Curtis damper regulator, steam and oil separators, pump governors and other devices. All these, which are made by the Julian d'Este Co., 24 Canal St., Boston, are shown in an attractive pocket catalog which the company is now sending out.

FORCE FEED LUBRICATION is of interest to every scientific engineer and the special points that Greene, Tweed & Co., of New York, wish to bring to the attention of those having lubrication in charge are emphasized in a cute little dodger in the form of a Japanese puzzle.

DRAW YOUR OWN CONCLUSIONS is the title of an attractive booklet from Chaplin-Fulton Mfg. Co., of Pittsburg. It shows the arguments for automatic feed-water regulation as against hand regulation, the economy of uniform feeding, the safeguarding to the boiler, the method of operation of the Vigilant feed-water regulator and the Fulton pump governor, and gives in illuminated headings and foot pieces charts showing the difference between the water level with automatic regulation and with hand regulation. It has some interesting tables also for steam engineers. If you are wise enough to ask for a copy and fortunate enough to get one, you will enjoy reading it.

THE GENERAL ELECTRIC CO. is just issuing a bulletin devoted to tungsten economy diffusers, which supersedes a previous publication on this subject. The new bulletin, No. 4,660, goes more into detail and contains illustrations of this diffuser in connection with fixtures of various designs. This publication will be of interest to those contemplating the use of tungsten lamps.

A PROBLEM IN PIPING AND FIFTEEN SOLUTIONS is the title of a 16-page, 6 by 9-in. pamphlet issued by the Harrison Safety Boiler Works, 3144 N. 17th St., Philadelphia, Pa. The problem was originally published in this company's advertisements in several of the technical papers, and the solutions here presented have been selected from those submitted by readers of the advertisements. The problem set is how best to connect up an exhaust steam heating plant in which there are 2 exhaust mains, one from the main engine, and one from the pumps, an open feed water heater and receiver, and a riser to the heating system, and the piping to be so arranged that the heating system shall at all times receive steam that has been purified of oil, and so that the exhaust of both pumps and engines shall be available for the feed water heater or for the heating system as required. Provision was also to be made for cutting the heater out of service for cleaning or inspection without interrupting the supply of purified exhaust to the heating system. While many of the solutions presented are ingenious, and some of them neat and practicable, most are defective in that it would be possible to subject the heater to high-pressure steam or to stall the engine, and all of them involve the use of an independent separator and trap, together with valves and other fittings, all of which, it is claimed, can better be replaced by the new Cochrane Steam-Stack and Cut-Out Valve Heater and Receiver. The new and peculiar feature of this heater is that it has attached to and forming a part of it an oil separator of sufficient capacity to purify all of the exhaust steam available, including that which goes to the heating system. It is also provided with valves for cutting the heater body out of circuit while the separator remains in service. The pamphlet will undoubtedly be of interest to all who are concerned with the design, installation or operation of exhaust steam heating systems.

AMMONIA FITTINGS AND SUPPLIES are a part of the product of the York Manufacturing Co., of York, Pa. The main product is refrigerating machinery, but the ammonia fittings and supplies are an important part of every refrigerating plant, and the complete and interesting way in which they are catalogued in the new book just sent out is evidence of the importance which the company attaches to this department of its work. The catalog has over 100 pages of illustrations and descriptions beautifully printed on a heavy enameled paper, and besides this has a section of tables and special information on refrigerating plant topics, which is well worth pasting in any engineer's notebook. The entire book is attractive and instructive and will be welcomed by those who receive it. It can be had by writing to the York Mfg. Co., York, Pa.

PRACTICAL STATIONARY ENGINEERING by West is one of the best books that has been prepared for operating engineers, and the seventh chapter of this is devoted to indicator practice, and is in simple clear style that makes it exceedingly valuable. The book is intended to help in passing examinations for license, and is well suited for this purpose. The article on the indicator has been reprinted in pamphlet form by the American Steam Gauge & Valve Mfg. Co., and is being distributed to its friends. This book is one of the best things in print, and the pamphlet is one of the best chapters in the book. It can be had by writing to F. A. Daly, 102 Pope Bldg., Boston, Mass.

TOLEDO PIPE THREADING DEVICES are made by the Toledo Pipe Threading Machine Co., of Toledo, Ohio, and are described in an attractive catalogue. The motto is, "One man does the work of two," and the catalog shows how this is accomplished. How to cut a 4-in. thread on a pipe in 10 in. clear space, threading a 6-in. well pipe in place, and a number of other seemingly impossible things, all are fully explained in the booklet and catalogue.

THREE INTERESTING PIECES OF READING are sent by the Sprague Electric Co. of New York City. One of these describes the Sprague Electric Hoist, showing the construction and the uses to which these hoists may be readily applied for saving of time and labor. The second is on flexible steel armored

hose for compressed air or steam, and explains the method of constructing this hose, and shows the kind of use and abuse that it will stand and where it comes in handy. The third is on Sprague Electric Fans for the summer of 1910 and is catalog No. 321, showing ceiling fans, column fans, desk and bracket fans, The Midget ceiling fan, and that for telephone booths. These fans are made in different sizes, and for either direct or alternating current as may be needed. The catalogue is interesting as a study of fan mechanism besides the interest it has in showing how to get hot weather comfort.

FROM THE PHILADELPHIA BOURSE comes the 19th annual report from the directors, showing what has been accomplished by the board during the past year, the value of the exhibits department, and the use that is made of the building by the business interests of Philadelphia.

SUMMER COMFORT AND HEALTH is the title of an attractive catalog sent out by the American Blower Co., describing the Sirocco Electric Fan and Air Purifier.

"MAKING HOT WEATHER DELIGHTFUL" is accomplished by means of the Ft. Wayne Fan Motors, the styles for 1910 being described in booklet 5022, just received from the Ft. Wayne Electric Works, of Ft. Wayne, Ind. Besides the usual wall bracket and desk fans, a little fan for the telephone booth and a revolving fan which continually turns in all the directions in the room, are notable. The booklet gives complete description and prices for all different types.

GOETZE'S METAL AND COPPER GASKETS and metallic packings are made by the American Goetze Gasket & Packing Co., of New Brunswick, N. J., who state as their purpose to provide an absolutely reliable packing for every use about steam and other plants where packing is required. The new catalog just issued by the company gives a list of the different kinds carried in stock, and shows the construction and the uses. It is full of novel ideas, and of packings prepared especially for difficult places. The catalog is ready for distribution to those who are interested, on application.

THE SMOOTH-ON INSTRUCTION BOOK which contains instructions for the use of the different grades of Smooth-On cement in making all sorts of repairs about the engine room and boiler room is now in its ninth edition, and contains all the interesting matter of previous editions with other material added. The new issue is ready for distribution, and will be sent free to any one upon request, by the Smooth-On Mfg. Co., of Jersey City, N. J. In requesting this book the name and the business address of the writer should be given.

"TESTS OF WASHED GRADES OF ILLINOIS COAL," by C. S. McGovney, is issued as Bulletin No. 39 of the Engineering Experiment Station of the University of Illinois. This bulletin presents the results of an elaborate series of boiler tests made in connection with a 210 horse-power brick-set water-tube boiler, equipped with a chain grate stoker. The fuel employed was washed Illinois coal of the various sizes commonly used for steam purposes. The description of the plant, the methods employed, and the results of the tests are given in detail.

Copies may be obtained gratis upon application to W. F. M. Goss, director of the Engineering Experiment Station, University of Illinois, Urbana, Illinois.

TRADE NOTES

THE GUANICA CENTRALE CO, which controls several of the largest sugar plantations in Porto Rico is now buying the necessary power and sugar machinery for a new mill. One of the features of the plant will be the use of gas engine alternators for supplying power and it is believed that this is the first large installation of this kind in the sugar industry. Allis-Chalmers Company has received the contract for the entire equipment, which will include the following apparatus: Three 18 by 24-in. single tandem gas engines each direct connected to a 250-KV. A., 3-phase, 50-cycle, 320-volt alternator, to run at 200 r.p.m. Each unit will be supplied with a belt-driven exciter. A 9-panel switchboard will hold the controlling apparatus. Gas will be supplied from 3 producers rated at 900 hp.

AMERICAN STEAM GAUGE & VALVE MFG. CO. has received many letters similar to the following which indicates the value of an indicator in the power plant: I have made a test of the Plant and reset the Valves by your Indicator, and no doubt the Company will appreciate the fact, as I have made a saving of coal amounting to 4 and 5 hundred pounds each day. I am quite sure this will bring about good results, both for the Company and myself. Respectfully yours.—H. H. Ripley.

V. D. ANDERSON CO., of Cleveland, which makes fertilizer machinery on a large scale, has arranged to install a 70 hp. Bessemer Gas Engine in its power plant for electric light and power. This will be a direct connected unit with generator armature placed on the engine shaft.

ELECTRIC MOTORS are taking the place of steam in many manufacturing plants, but for a quick change the Gandy Belting Co., of Baltimore, Md., manufacturers of the Gandy Stitched Cotton Duck Belting, seems to have broken all records. On March 9 last the 150 hp. steam plant of the Gandy Co. broke down. By noon the following day, just 24 hr. later, the entire plant was again in operation. The 150 hp. is furnished by 2 motors, one of 100 and one of 50 hp. At the time of the breakdown, the 100 hp. motor was in Philadelphia, which will give some idea of the difficulties encountered.

GREDAG IS THE TRADE NAME adopted by the International Acheson Graphite Co. for its Graphite Grease in order that it may be distinguished from the grease products which contain impure natural graphite. The graphite blended with a high-grade grease in Gredag is an electric furnace product—the purest in the world. As it is soft and unctuous, this graphite is a perfect lubricant in itself, but in Gredag are combined all the merits of both graphite and grease, the combination making a lubricant of high quality and value.

THE BAYER SOOT BLOWER SYSTEM has received a most satisfactory and convincing endorsement from the Heine Safety Boiler Co. After nearly 2 yrs'. trial in daily use in their own plant subjecting the system to the most severe tests that they could devise they have made a contract with the Bayer Steam Soot Blower Co. to equip every boiler which the Heine Co. builds with the Bayer system.

GRIP COUPLINGS for connecting steam, water, gas, air and chemical piping without threading are made by the Grip Coupling Co., who have recently removed to Morse Avenue, Ware, Mass.

BANANA OIL, which can be obtained at any drug or paint store, is a good preventive of rust. After polishing the article, apply the oil with a soft brush.

PRACTICAL ENGINEER CLASSIFIED ADVERTISEMENTS

Advertisements in this section are inserted under regular headings at the rates of 40 cents per line. About nine words make a line. No display type is allowed, but the first three words may be set in capital letters. Minimum space sold, two lines.

Under classification, "Positions Wanted," advertisements not exceeding four lines will be inserted for subscribers once free of charge.

To insure proper classification, copy must reach this office on or before the 15th of month preceding publication.

Positions Wanted

POSITION WANTED as traction or small stationary engineer, 29 years of age and experienced with both. Address G. G. Lewis, R. F. D. 2, Box 27, Warrensburg, Ill. 6-1

CHIEF ENGINEER desires change of position, technical education, with large experience in power plant work. Wants position with concern where hard work and ability count. Either large manufacturing plant or electric railway preferred. Address Box 134, Practical Engineer. 6-1

POSITION WANTED—High grade salesman, age 35, desires change; experienced in steel, power machinery and heavy lines, with record proving ability to close large sales; confidential correspondence invited. Address S. S., Practical Engineer. 4-2

Help Wanted

ASSISTANT SALES MANAGER WANTED—Power plant equipment manufacturing company in East require an assistant sales manager, having technical education, practical motive power experience and demonstrated capacity for organization, correspondence and sales getting. Address in confidence with full particulars, including salary expected. Business Service Co., New York City. 6-1

A LARGE ELECTRICAL CONCERN has vacancy for a superintendent of their plant. Product is both light and heavy; about half of output consists of ammonia compressors. Applicant must have good executive ability, be able to combine aggressiveness with diplomacy and must assume charge of entire work. A permanent position is assured to the right man. Address Box 135, Practical Engineer.

SALESMAN—The Reagan Grate Bar Co. are looking for first class men to sell Reagan Grates and Stoking Devices (see our advertisement on page 150). Only those who have had experience in selling Grates or Stokers and who are familiar with steam and bituminous coal need answer. Will pay fair commission on all sales. Answer giving full particulars to Reagan Grate Bar Co., 211 N. Front St., Philadelphia. 6-1

AGENTS WANTED to sell Burgmann celebrated engine packings in territories not yet covered. See our advertisement on page 121 of this issue.

WANTED—AN ENGINEER in each town to sell the best metallic packing for steam, air, gas and ammonia. Write Ideal Metallic Packing Co., South Stillwater, Minn. 5-tf

WANTED—ENGINEER in every town or city. You send us the names, we sell the goods and pay you the commissions. Write for particulars. The Lloyd Mfg. Co., Menominee, Mich. 5-1

AGENTS WANTED—West of Buffalo and Pittsburg to sell a necessary power plant specialty that is a big money maker. We allow a liberal commission. Address, stating experience, Box 126, Practical Engineer. 3-tf

WANTED—A hustling general superintendent for a small electrical plant manufacturing electric vacuum cleaners. A good salary and an excellent opportunity for advancement is offered to a competent general superintendent. Must be a hustler, able to get work through the shop and a good organizer. Address Box 130, Practical Engineer. 5-2

ENGINEERS AND MECHANICS—To make big money selling Incomparable "ZIZ" Hand Soap. A 10-cent can will instantly remove more dirt and stains from the hands than four cakes of any soap made, and it will not injure the most delicate skin. Small sample free. Byram Mfg. Co., Box 3133, Boston, Mass. 4-tf

WANTED—Established and experienced engineering specialty salesman to sell, on commission basis, to power plants and jobbers in exclusive territory, the most widely advertised specialty of its kind; used by every power plant in the country. We have a particularly attractive proposition. State Experience. George M. Newhall Engineering Co., Philadelphia, Pa. 4-4

For Sale

FOR SALE—COMPLETE SETS OF CASTINGS and material for neatly designed horizontal 1-16 Hp. steam engine. Engine has governor on cut off principle, rotary valve and adjustment for wear. A novice can build one with the help of our blue prints and instruction sheets. Castings and material, $1.50. Blue prints and instructions, 25 cents. Pat Novelty Co., Box 193, Elgin, Ill. 6-1

FOR SALE CHEAP—Belt-driven air compressor, side valve engine and two boilers. National Can Co., Detroit, Mich. 4-3

FOR SALE—Patent No. 897285, an entire metallic automatic return valve for use in connection with vacuum heating system. No carbon or rubber cores, no springs, no floats. Perfect operation from 150-pound steam pressure to under any degree of vacuum. Also patent No. 791773 on the "Greenaway" cast iron exhaust head, the original cast iron exhaust head; over 1,000 in successful operation. Both these patents will be disposed of at a low figure to the right party. Address A. J. Greenaway, 1206 Chamber of Commerce, Detroit, Mich. 4-2

Patents and Patent Attorneys

FREE BOOKLET—All about patents and their cost. Shepherd & Campbell, Patent Attorneys, 500 M. Victor Bldg., Washington, D. C. 5-tf

DIETERICH'S 50 PERPETUAL MOTIONS—100 mechanical movements; books tell about perpetual motion and how to obtain patents; by mail for 25 cents, postage or coin. F. Dieterich & Co., Patent Lawyers, 64 Oray Block, Washington, D. C. 4-tf

PATENTS—C. L. Parker, late Examiner U. S. Patent Office, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. 186 McGill Building, Washington, D. C. 4-tf

Educational and Instruction

MECHANICAL DRAWING—Ten lessons one dollar. Additional lessons ten cents. Lucian Jones, 115 South 54th St., Philadelphia. 3-2

Miscellaneous

COUPLINGS—Cash paid for your surplus couplings and fittings. Write us, stating what you have. The A. & J. Manufacturing Co., 425 W. Randolph St., Chicago, Ill. 6-1

WANT RESPONSIBLE CONCERN to handle our well-known combined feed water heater, and purifier on royalty. Also manufacture same. Standard Machinery Co., 738 Madison St., Chicago, Ill. 6-1

EVERY ENGINEER should know about the new system of Vacuum Heating which can be installed without payment of royalty. Particulars will be cheerfully furnished. T. L. Reeder, 1413 W. Jackson Blvd., Chicago.

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